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SYNOVIAL SARCOMAS IN JOINTS, BURSAE, AND TENDON SHEATHS

A Clinical and Pathological Study of Sixteen Cases

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CLINICOPATHOLOGICAL knowledge of sarcomatous tumors in general has lagged somewhat behind similar knowledge of epithelial tumors. The former show such marked histological variability that classification is frequently an expression of individual opinion. While in many instances, the classification of sarcomas may seem to represent an academic nicety, nevertheless it is highly essential if one is to draw accurate statistical conclusions and avoid misinformation as to the efficacy of any form of treatment. Progress in the study of mesenchymal tumors, however, is surely being made, and the identification of a synovial sarcoma with specific synovial characteristics represents an achievement in this direction.

Synovial sarcoma would appear to be a rare disease if the reports in the literature are to be regarded as trustworthy. It is our feeling, however, that this rarity is far more apparent than real. Histological recognition of the tumor is often difficult unless certain specific features are demonstrable. Failure in this regard will relegate the tumor to an improper category. Moreover, clinical recognition is difficult particularly as regards the intra-articular tumors involving the knee joint. Here the disease remains undiagnosed for from 5 to 6 years, and the patients are usually treated for chronic synovitis or for cartilage injuries.

There have been several excellent communications on synovial sarcomas, notably those of Sabrazes and his associates and those of Knox and of Berger. Wagner reported the first case in the American literature. This was studied by Ewing who called it a "fibro-endothelioma" of synovial origin. Coley's paper deals with the clinical features of the disease as they appeared at that time. The older literature is inadequate in that pathological descriptions are so incomplete and end-result studies so poor that conclusions are misleading. Mention should be made, however, of the papers of Stuer, and of Lejars and Rubens-Duval. The former described an "adenosarcoma" of the elbow region identical with our Cases 1 and 2; the latter described with excellent illustrations a similar tumor of the knee joint,and independently called attention to the fact that the tumor in some areas resembled an epithe-

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lioma and in other areas a sarcoma. An "epitheliosarcomatous" histological appearance has thus become identified as a striking feature of most synovial sarcomas.

Smith, writing in 1927, rediscovered these tumors and coined the designation "synovioma" to indicate their specific synovial nature and origin. This term unfortunately suggests a benign tumor. Mere synovial localization does not suffice to establish a tumor as a "synovioma." Thus a hemangioma or chondroma of the synovial membrane is not a synovioma. The term "synovioma" has found such general acceptance however that it is difficult to displace. We are inclined to favor Berger's suggestion of "synovialosarcoma" or synovial sarcoma for the malignant tumors of specific synovial origin.

CLINICAL STUDY

The present study of 16 cases of synovial sarcoma was undertaken in a further attempt to study this obscure disease clinically and pathologically.

Gross anatomy. Synovial sarcomas originate in synovial tissue and thus are found in joints, para-articular bursae, and in tendon sheaths. In general they occur in or near a joint and since the relationships of the different synovial tissues are extremely variable and complex, it is often difficult in an individual case to establish the exact site of origin. This difficulty is enhanced when the tumor is of wide extent and of infiltrating character. Moreover, the intra-articular synovial membrane is so frequently continuous with that of the para-articular bursae that bursal and intra-articular involvement may be simultaneous or successive.

Anatomically the tumors fall into 3 groups: (1) encapsulated—Cases 1, 2, 3, 8, 9, 10; (2) circumscribed—Cases 4, 6, 12, 13, 14, 15, 16; (3) diffuse—Cases 5, 7, 11.

The majority of encapsulated tumors take origin from the synovial membrane of a para-articular bursa and the capsule is formed by the bursal wall. Circumscribed tumors may originate in a bursa or a tendon sheath. Diffuse tumors are classically seen within the knee and show simultaneous or successive involvement of joint, suprapatellar pouch, and popliteal region. Indeed, they may even invade the adjacent bones.

The gross appearance of the tumor is subject to considerable variation. It may be solid, fibrous, and homogeneous, essentially like an encapsulated fibrosarcoma. In general, however, it appears soft, and myxomatous at least in areas. Grossly cystic areas and clefts are occasionally recognized. Yellow-brown pigmentation of the tumor with hemosiderin is sometimes observed, similar to that of the benign xanthomatous giant cell tumor (Cases 10, 13, and 14). Focal areas of calcification, chondrification, and ossification are found more frequently than in other soft tissue sarcomas (Cases 1, 3, 6, 8, 9, 11). Broders encountered calcification in only 11 of 152 cases of soft tissue sarcoma, and Shields Warren, who reviewed 155 cases, did not mention it at all. Moreover, it is not unlikely that among fibrosarcomas showing calcification and ossification there may not be some overlooked synovial sarcomas, since the pathological distinction is often impossible without prolonged study.

Location. The location of the tumor in our 16 cases, to which are added 21 authentic cases from the literature, is shown in the table. Although the series is small, it is impressive in that approximately half of these tumors occur in or about the knee joint.

Site of lesion	Total number of cases	Location		
		Articular	Para-articular	
			Bursa	Tendon
Knee	18	11	6	1
Elbow	7	2	5	0
Forearm	2	0	0	2
Shoulder	2	0	1	1
Finger	3	0	0	3
Thigh	4	0	4	0
Foot	1	1	0	0
Totals	37	14	16	7

ETIOLOGICAL FACTORS

The etiological factors to be considered are: (1) The rôle of trauma; (2) the influence of chronic bursitis or chronic synovitis; (3) age incidence; (4) sex incidence.

Trauma. Trauma was mentioned in 4 cases, in all of which the knee joint or its adjacent bursae was involved. In 3 cases the trauma was severe and direct, whereas in 1, it was indirect. In 1 case careful history elicited the onset of symptoms prior to trauma. Twelve cases gave no history of trauma. It seems most likely that trauma occasionally initiated the onset of symptoms but by no means produced the tumor.

Chronic bursitis or synovitis. The progression of an inflammatory hyperplasia into a neoplasm has often been recorded. One of our cases (Case 3) occurred in an olecranon bursa with a 10 year pre-operative history and strongly suggests that a previous bursitis may occasionally predispose to the development of a synovial sarcoma. The frequent localization of the knee tumors in the popliteal space where bursae are so prevalent, and the coexistence in both the benign bursa and the malignant tumors of blood pigment, bone, and cartilage, arouses further suspicion that, in rare instances, a chronic bursitis may predispose to the onset of a synovial sarcoma. The long duration of symptoms in the intra-articular knee joint cases also raises the query as to whether these were primarily, or became secondarily, malignant.

Age at onset of symptoms. The age incidence is predominantly between the twentieth and fiftieth year with the average at 34 years. In Berger's composite series of 24 cases from which we have excluded 3 cases[1], the average age was 35.4 years. The age incidence is notably younger than that for fascial sarcoma or fibrosarcoma of bone. In the former Broders finds an average of 43.2 years. In Warren's group of fibrosarcomas the average age is about 50 years. Smith, however, encountered an undoubted synovial sarcoma in a 7 year old girl. The tumor was located in the right knee and symptoms of internal derangement had been present for about 3 years.

Sex. Synovial sarcoma occurs more frequently in the male sex—11 of our 16 cases and 13 of Berger's 21 cases. For the combined series the incidence is 24 males and 13 females. This differs but slightly from the sex incidence of fascial sarcoma as reported by Broders and by Warren.

[1] Berger's Case 4 was excluded because of incomplete data, his Case 9 is our Case 10, and Berger's Case 10 we re-examined and found to be a typical xanthomatous giant cell tumor.

SYMPTOMS

Clinical symptoms of synovial sarcoma are neither striking nor characteristic. In xanthomatous giant cell tumor of joints and in hemangiomas of the knee joint, the symptoms are frequently of sufficient uniformity to permit of pre-operative diagnosis. An analysis indicates that (1) pain, (2) tumor, (3) joint dysfunction, (4) occasional fluid swelling of a joint comprise the chief clinical symptoms.

Pain. Pain is not a constant feature being present only in 8 of our 16 cases. Here the duration of pain varied from 9 months to 10 years, and the patients were usually treated for synovitis. In all of the cases involving the knee joint, however, pain was present and the majority of these showed diffuse invasion of joint and para-articular structures. Some cases showed gross implication of a nerve trunk. Pain was absent or inconspicuous in the encapsulated or circumscribed para-articular tumors. Three of the painful cases involving the knee joint were explored and external semilunar cartilages were removed without the nature of the disease being discovered (Cases 2, 4, 11). Indeed, 1 case, Case 7, had two explorations without discovery of tumor. Many tumors were painless, localized, or encapsulated swellings as in Cases 1, 2, 3, 4, 9, 13.

Tumor. Tumor was noted by the patient in 10 of 16 cases. The known duration of tumor varied from 1 month to 10 years with the average at 29 months. The location of the tumor undoubtedly influenced its discovery. Superficial tumors, as in the cubital fossa, olecranon, or wrist appeared early. Tumors concealed within the knee joint, popliteal space, or suprapatellar pouch eluded discovery for an average period of 5.6 years.

Dysfunction. Dysfunction was present in 10 of 16 cases. It varied from slight restriction of motion to a severe painful flexion contracture, as illustrated in Case 4. Dysfunction was caused either by intra-articular involvement, or by pressure upon the joint structures by an adjacent tumor.

Swelling. Fluid swelling occurred in only 2 of the 16 cases. Both cases (11 and 14)

showed intra-articular involvement. Centrifugation of the joint fluid and examination for tumor cells was unsuccessfully attempted. Fluid swelling, which is quite common in joint xanthoma, would thus appear to be present only in intra-articular synovial sarcoma.

Duration of symptoms. The average pre-operative duration of symptoms for the entire series was 36 months with extremes at 1 month and 10 years. The series is too small to permit correlation of the pre-operative duration of symptoms with end-results. If those cases showing intra-articular knee involvement are considered separately, however, the pre-operative duration of symptoms was 5.6 years. Prolonged painful disability in a knee should always be regarded with suspicion.

ROENTGENOGRAPHIC EXAMINATION

X-ray examination was made in 13 cases and in 10 of these, a soft part tumor near a joint was visualized (Cases 1, 6, 8, 9, 10, 11, 13, 14, 15, 16). In 4 cases (Cases 1, 6, 8, 9) the tumor showed irregular calcification which facilitated x-ray visualization. In 2 cases (Cases 10 and 11) the tumor was overlooked on first examination but was readily discovered on review of the original films. One case (Case 5) showed increased intra-articular soft part thickening 5 years before the diagnosis of synovial sarcoma was established, but this was not regarded with suspicion. Exception must be taken, therefore, to the statement that x-ray films of synovial sarcoma are usually negative. Closer attention to soft tissue detail will undoubtedly lead to their more frequent discovery. Not unlikely, pneumarthrography will further improve x-ray diagnosis. In Cases 5 and 8 extensive destruction of the bones comprising the knee was found without confirmatory x-ray evidence. A more comprehensive review of some of the roentgenographic features of synovial sarcoma are to be found in an article by Raymond Lewis.

TREATMENT AND END-RESULTS

The previous treatment accorded to synovial sarcoma has in our opinion erred by being too conservative. Treatment has generally consisted of local excision followed by delayed amputation, unless the course of the disease was interrupted by widespread metastases. The frequent small size of the tumor, its encapsulation, and the long pre-operative duration of symptoms, all obscure the undoubted malignancy and lull the surgeon into an erroneous sense of security which is not warranted by the end-results.

Treatment by local excision. In general, treatment of an accessible and resectable tumor by local excision results in prompt recurrence and essential widespread metastasis. This statement is based upon an analysis of 13 cases which had undergone primary local excision (Cases 1 to 4, 6, and 8 to 15). Of these 13 cases, recurrence was prompt in 10, in an average interval of 8.9 months, necessitating either secondary excision or amputation. One patient, Case 1, is believed to have developed axillary metastases, and 2 patients, Cases 2 and 9, seem well without disease but have been followed for only 14 and 9 months, respectively. One patient, Case 12, however, is well 3 years after two excisions in spite of a prompt recurrence. Histologically, it seems to be a less malignant variety of the tumor.

Treatment by delayed amputation. In 7 cases (Cases 5, 7, 8, 10, 11, 12, and 14) patients were treated by delayed amputation. This delay in amputation was usually the result of inability to arrive at a proper diagnosis. Five of these (Cases 8, 10, 11, 12, and 14) had received one or more local excisions followed by prompt recurrence. Six of the 7 cases involved the knee joint and the seventh involved the flexor tendon of the ring finger. There are only 2 survivals of this group, Cases 12 and 14 for 22 months and 1 year, respectively.

One conclusion that can be drawn from this small group of cases is that delay in amputation is not permissible in diffuse intra-articular synovial sarcoma.

Value of x-ray therapy. It is virtually impossible at this time to evaluate the efficacy of x-ray therapy. Ewing recently stated that in his experience synovial sarcomas responded rather favorably to intensive deep irradiation. In 8 of our cases (Cases 1, 4, 8, 10, 11, 12, 15, 16) patients received intensive deep x-ray therapy, after local excision. The tumor in

Case 1 has not recurred but patient has developed axillary metastases; in Cases 4, 8, 10, 11, 12, 15, and 16, lesions recurred promptly; Case 10, patient survived 10 years before dying of metastases, however. Patients in Cases 8, 10, 11, 15, and 16 did not survive a 3 year period and in Case 4 a prompt local recurrence is scarcely compatible with a long survival.

The final chapter in the proper treatment of synovial sarcomas will undoubtedly require revision. We believe, however, that for the localized or encapsulated tumors, radical excision followed by intensive irradiation will permit time for pathological examination and gradation of the malignancy of the tumors. Whereas all synovial sarcomas are malignant, there can be no doubt that the grade of malignancy follows the general rules for all malignant tumors. We believe that the vast majority will require prompt amputation and that the decision as to amputation cannot be too long deferred. Pathological distinction from the benign xanthomatous giant cell tumor is important to avoid needless sacrifice of an extremity. It may be justifiable in occasional instances to allow time for a single recurrence, but it is never justifiable to await more than one recurrence. The general practice of treating soft tissue sarcomas by repeated local excision has certainly not yielded brilliant therapeutic results. Broders found from 7 to 45 per cent 5 year cures depending upon the degree of malignancy of the tumors and Warren reported 35 per cent 3 year cures. Coley is convinced that the treatment of soft tissue sarcomas by repeated local excision results in more fatalities than would result if early amputation were more frequently resorted to. Sabrazes would treat all synovial sarcomas by primary amputation.

Treatment of diffuse synovial sarcomas, such as those which involve the knee joint, should be primarily radical at the outset. Here the tumor usually involves joint, quadriceps pouch, and popliteal space, and attempts at local removal cannot fail to be inadequate. Treatment may thus be summarized:

1. Accessible tumors usually encapsulated should be treated by widespread local excision. Pathological examination will permit gradation of the tumor and allow a short period of observation. Amputation may be deferred to the time of the first recurrence but never beyond this.

2. Inaccessible or unresectable tumors such as those of intra-articular localization should be treated by immediate primary amputation.

3. X-ray therapy may retard the growth of some tumors and can be employed after local excisions.

HISTOLOGY AND PHYSIOLOGY

Before undertaking a discussion of the histological features of synovial sarcoma it is well to review existent concepts concerning the structural and functional characteristics of normal synovial membrane.

In a previous communication, Wilson and one of us reported 9 intra-articular xanthomatous giant cell tumors of synovial origin. At this time the conclusion was formed that the tumor arose as a proliferation of synovial lining and subsurface cells in which the evolution of the tumor was frankly histiocytic. The plasmodial giant cell, the large foam or xanthoma cell, the mononuclear cells with intracellular hemosiderin pigment, the so called "stroma" cells, and the lining surface cells were all regarded as modifications of a fundamental cell type or histiocyte. At this time, the authors were unfamiliar with the histological studies of Francescini and the tissue culture experiments of Vaubel to whom priority is acknowledged for recognizing the histiocytic nature of the synovial membrane.

Berger added additional histological evidence of the histiocytic nature of xanthomatous giant cell tumors by demonstrating an abundant delicate argyrophilic reticulum throughout their substance. In cutaneous xanthomas which are more properly lipoid histiocytomas, there exist, as Senear and Caro have shown, all transitions from a cellular histiocytic tumor without xanthoma cells but with abundant lipoid demonstrable by sudan staining to an obvious xanthomatous tumor containing many foam cells. We have also demonstrated an abundant arborescent argyrophilic reticulum in these tumors, which these authors did not point out.

It seems quite apparent, therefore, that in histological study the histiocyte can at present be demonstrated in one or all of the following ways: (1) demonstrable lipophagic properties, (2) demonstrable siderophagic properties, (3) reticulin production.

In addition, the histiocyte possesses an endothelial appearance and tends to be polymorphous.

In the knee joint of the 4 month embryo we have observed a syncytial structure of the entire synovial mesenchyme manifested more prominently by a characteristic reticulum. Thus it may be stated that this histiocytic property of reticulin production in the synovial membrane, becomes apparent at an early embryological age. Border cuboidal cells do not appear conspicuous and probably make their appearance at a later date. It cannot be assumed, however, that the mere demonstration of reticulin is always synonymous with a histiocytic origin. In rhabdomyosarcoma, for example, reticulin production is sometimes as striking in our material as in so called reticulum cell sarcomas. There is great need for additional clarification of the complex problem of reticulin production in normal tissues and in connective tissue tumors.

Vaubel studied synovia by means of tissue cultures and pointed out peculiarities which distinguished it from originary mesenchyme. These were (1) a polymorphism of the cells in cultures with a tendency to produce round, spindle, polygonal, and epithelioid cells and (2) a functional characteristic, namely the formation of synovial mucin. Berger reviewed the varying concepts concerning the true nature of the synovial membrane. He has regarded it as an histiocytic tissue related to the reticulo-endothelial system and capable of assuming different functional and histological appearances: (1) a truly endothelial lining function played by the border cells, (2) a mucin-forming function, and (3) a histiocytic function—exhibited histologically by lipophagic and siderophagic properties, and by the production of a fine reticulin about the cells.

The classical experiments of Key and others demonstrated the phagocytic and migratory character of the synovial cellular constituents when foreign materials were introduced into joint and further support the concept of the reticulo-endothelial nature of synovial membrane. In various forms of hemorrhagic synovitis, the siderophagic ability of both border and subsurface synovial cells is strikingly exhibited.

HISTOLOGY OF SYNOVIAL SARCOMA

All or any of the normal characteristics here mentioned are varyingly exhibited in the sarcomas of synovial origin. Frequently all these features co-exist as subsequent histological descriptions will show. In some cases the evolution of the tumor may be predominantly one-sided and overshadow other characteristics. The histological appearance of fibrosarcomas and spindle cell sarcomas of fascial or periosteal origin is more characteristically uniform. Here, as Broders states, a small area serves to identify and grade the tumor. For the identification of specific synovial characteristics, however, multiple sections and careful differential staining are essential because the development of the tumor may be notoriously heterogeneous.

Endothelial characteristics exhibit themselves within the tumor, characteristically as epithelioid gland-like spaces often enclosing mucin, or by reproduction of pavement-like areas of tissue strongly resembling epithelium, or again, as neoplastic synovial villi. When these characteristic features are strikingly developed, histiocytic features may be partly suppressed, although with reticulum stains, one can generally identify two cell types in the tumor: one, having the properties of a reticulum cell and another retaining endothelial or epithelial properties.

Mucin production may be confined to gland-like spaces or may appear as small interstitial accumulations among the endothelial components of the tumor cells. Grossly, mucin production makes areas of tumor appear myxomatous or gelatinous.

Histiocytic properties may be exhibited in several ways:

1. The tumor may closely resemble a reticulum cell sarcoma and be composed of rounded, oval, or reniform nuclei supported by a prominent argyrophilic reticulum. Here and

there one may find a gland-like space although this endothelial expression may be suppressed or limited to occasional microscopic areas.

2. The tumor may be a polymorphous sarcoma with giant cells, irregular mononuclear, multinuclear cells, blood pigment again supported by a profuse argyrophilic reticulum; although such a tumor may superficially appear different from this description, it is essentially the same.

3. The histiocytic evolution may take the form of sheets of xanthoma cells identical with those found in the benign xanthomatous giant cell tumor (see Case 4).

In general therefore all synovial sarcomas are reticulo-endothelial histiocytic sarcomas with varying degrees of reticulum production and endothelial evolution.

Many areas of the tumor may show indifferent fibrosarcomatous characteristics, but careful study of multiple areas will reveal the telltale specific characteristics. For this reason any fibrosarcoma or spindle cell sarcoma located in or near a joint is very likely a synovial sarcoma, although proof of its identity must depend upon painstaking pathological investigation.

For convenience, the appearance of the various histological expressions of synovial specificity in tumors are summarized in table, "malignant neoplasms."

MALIGNANT NEOPLASMS—SYNOVIAL SARCOMAS (SYNOVIOMAS)

1. Reticulo-endothelial characteristics (Cases 1, 2, 3, 4, etc.).
   a. Composed of spindle cells (reticulum positive) and pale endothelial cells (reticulum negative).

   The endothelium may appear as:
   a. A homogeneous pavement-like structure with or without intercellular mucin
   b. Gland-like spaces with or without mucin
   c. Papillary villi-like structures (malignant synovial villi).
   d. Synovial borders resembling hyperplastic synovial membrane.
2. Predominantly histiocytic features
   a. Polymorphous giant cell features, intracellular blood pigment (Cases 13 and 14 and areas of 10)
   b. May also contain cartilage (Cases 13 and 14)
   c. May reproduce synovial borders.
3. Common fibrosarcoma or spindle cell sarcoma features may mask a true synovial sarcoma (Cases 6, areas of 10).

Our observations closely parallel and confirm those previously reported by Berger. However, we have been impressed with the extensive calcification, chondrification, and ossification which so frequently take place as scarcely to be coincidental. Calcification occurred in 6 of the 16 cases and had a predominate influence upon x-ray visualization. The calcium was deposited as small or large deposits in an afibrillar albuminoid interstitial substance not unlike that which forms the preosseous substance of newly formed callus. Calcification was not related to x-ray therapy since it was discovered in each case before therapy was instituted. Two additional cases (Cases 12 and 13) showed large islands of fibrocartilage which led to the diagnosis of "chondromatous giant cell tumor."

Chondrification and ossification are less readily explained. In some instances it seemed to result from metaplasia. We suspect that it is closely related to the mucigenic tendency of synovial mesenchyme. Chemically, mucin is closely related to the ground substance of cartilage. Therefore, the detailed explanation of this complex tissue phenomenon must await further elaboration.

MALIGNANCY OF SYNOVIAL SARCOMAS

All synovial sarcomas are malignant but in all probability all are not equally malignant. It would be premature at this time to attempt a histological grading similar to that of Broders for fascial sarcomas. Nevertheless, at the risk of being premature, one may hazard some expression of opinion as to the relative malignancy of the different forms.

The least malignant tumors are those showing a high degree of histiocytic differentiation characterized by numerous multinucleated giant cells and pigmented cells, and fibrous areas. These tumors resemble somewhat the xanthomatous giant cell tumor or benign histiocytoma, although foam cells have been less conspicuous. Four of 16 tumors prominently exhibited these characteristics. Two patients showed prompt local recurrence. One such patient treated by two local excisions is well without disease after 3 years. One patient, however (Case 10), showed late metastasis and succumbed.

The most highly malignant forms are probably those tumors composed of numerous,

densely packed, round, oval, and reniform cells with abundant supporting reticulum. Experience indicates that these recur promptly and metastasize quite promptly to lungs, vertebrae, skull, and internal organs.

The tumors showing prominent endothelial characteristics with gland-like spaces, appear to lie intermediate in their malignancy, although all are undoubtedly capable of widespread metastasis.

CASE REPORTS

CASE 1. Synovioma of right antecubital fossa. E. P., male, aged 30 years. Treated by local excision and irradiation. Alive with axillary metastases after 14 months.

A tin splitter, aged 30, was admitted to the Englewood Hospital, on May 2, 1939, for acute appendicitis. He also complained of difficulty in flexing and extending the right elbow joint, for the past 6 months, and of a mass in the antecubital region.

Examination revealed that in addition to the signs of acute appendicitis, the patient presented a marked prominence of the anterior surface of the flexor group of muscles, overlying the anterior surface of the elbow joint. Extension was limited to 135 degrees, flexion to 90 degrees. Rotation was unimpaired. An x-ray film of the right elbow joint disclosed a circumscribed soft tissue shadow extending to the humeroulnar articulation with small foci of calcification. A pre-operative diagnosis of fibrosarcoma was made and on May 9, 1939, a local excision of the tumor was performed.

Pathological report. The specimen consisted of an encapsulated gray mass 4.5 by 2 centimeters with adherent synovial fringes. When sectioned the mass was found to be cystic and within the cyst were soft, gray papillomatous nodules, the largest about 1½ centimeters in diameter; undoubtedly the tumor originated from the synovial membrane, either of the joint or from a synovial-lined bursa overlying the joint.

Microscopic sections prepared through the thickened area of the cyst wall showed a tumor which was highly cellular and exhibited many mitotic figures. There were two cell types in the tumor. One was an endothelial cell with an oval, pale nucleus and an indistinct cytoplasm. These cells were arranged in rather compact masses and were supported by an amorphous pink-staining substance which in places was rather abundant and resembled a secretion of mucin. The other type of cell was somewhat more elongated, with a darker staining nucleus and was arranged in anastomosing masses. In one area the tumor had a papillomatous appearance, reproducing tufts resembling neoplastic villi. Here the surface cells assumed a cuboidal character. Mucicarmine stains revealed irregular pink-staining threads and strands which had the staining qualities of mucin. These seemed to be confined to the endothelial areas of the tumor or about the neoplastic villi. With Laidlaw's reticulum stain the difference between the two cell types was greatly accentuated. Pale, non-staining areas corresponded to the endothelium-like cells. The darker staining spindle cells were individually supported by a delicate reticulum. Other areas showed coarse deposits of calcium and true bone and about these areas the tumor assumed the character of collections of gland-like spaces composed of cuboidal cells. These were identical with areas from several other tumors.

Patient refused amputation and was given deep x-ray therapy to elbow and axilla. He was last seen in July, 1940, at which time discrete nodular masses were present in both axillae. Roentgenograms of the chest at this time were negative for metastases.

From a histological standpoint, this case is a classical synovial sarcoma identical with Berger's Case 2. Small and large gland-like spaces, though not numerous, were present and papillary neoplastic villi predominated in other areas. Gland-like spaces also appeared lined by cuboidal cells and mucin was produced by the tumor.

Clinically, the patient already has shown evidence of extension of the disease.

CASE 2. Encapsulated synovioma of right cubital region. Probable origin in bursa. Treated by local excision. Alive without evident disease after 11 months.

J. B., aged 63 years. Two years ago the patient noticed a small mass on the medial aspect of the right elbow joint. This gradually increased in size until 6 months ago when it began to enlarge more rapidly. On examination there was found a soft, almost cystic mass 5 centimeters in diameter at the medial aspect of the right elbow. There was no axillary adenopathy. On August 17, 1939, the tumor was removed by local excision. It did not communicate with the joint, or a tendon sheath.

The tumor was an encapsulated lobulated mass measuring 6 by 5.5 by 3 centimeters. The capsule was made up of strands of glistening tissue throughout which could be seen projecting gray and yellow nodules. It was soft in consistence and on section showed a homogeneous cut surface of glistening pinkish-white tissue in which whorls of dense tissue could be seen. When the cut surface was spread slightly, slit-like spaces were seen between the bundles and whorls.

The tumor was enclosed in a well defined fibrous capsule which in areas showed microscopic infiltration and replacement. It was composed of cells with pale endothelial nuclei and an indefinite cytoplasm drawn out into elongated spindle processes. The bulk of the collagen was intracellular but areas revealed moderate intercellular collagen. In many areas the collagen was more prominent, revealing itself as definite septa subdividing the tumor into rounded

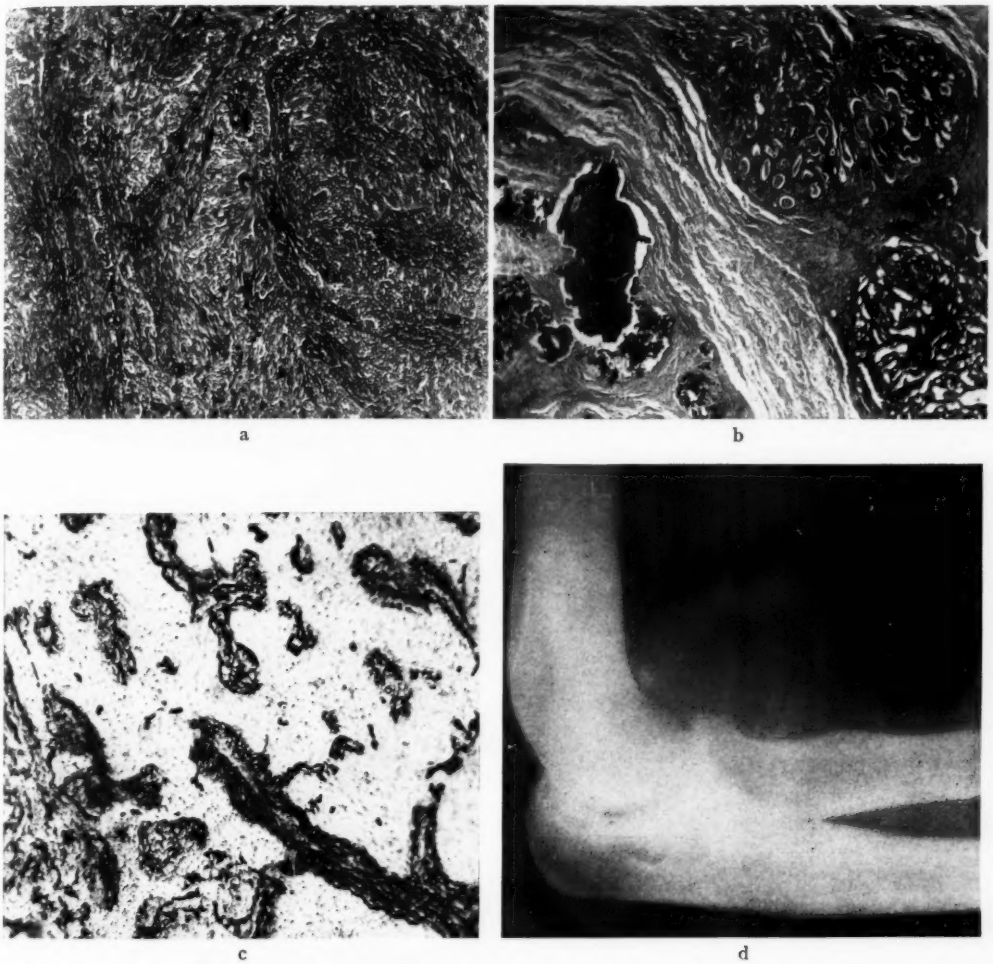

Fig. 1. Case 1. a, Photomicrograph showing general epitheliosarcomatous character of tumor. Note that there are two types of cells, darker staining reticulin positive and paler staining endothelial cells. ×80. b, Photomicrograph of another area of tumor showing amorphous deposits of calcium to the left and characteristic gland-like spaces to the right. ×25. c, Characteristic area of tumor, Laidlaw stain. The darker cellular elements are reticulin positive. ×90. d, Roentgenogram of tumor showing focal calcification.

nodules. In every microscopic field there were present great numbers of rounded, oval, and irregularly shaped gland-like spaces lined by cells which resembled cuboidal epithelium. On superficial examination one would be inclined to diagnose this an "adenosarcoma." The space formation exceeded that encountered in any of the 16 cases of the series. The transition between spindle and cuboidal cells in the tumor was extremely gradual. Other areas near the margin of the growth revealed predominately fibrosarcomatous characteristics, but even here there were slit-like clefts in the tumor with spindle cells playing the border rôle. Reticulum stains were negative, however.

In July, 1940, eleven months after operation, patient was examined and found to be free of recurrence. There was no clinical evidence of pulmonary metastasis.

This case is histologically similar to Cases 1, 5, 7. It is the classical "adenosarcoma" of Stuer even in its location. Its origin was prob-

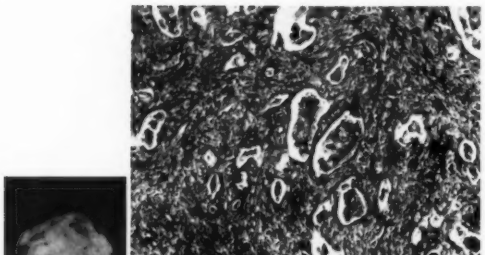

Fig. 2. Case 2. a, left, Cross section of tumor. b, Photomicrograph. The histological appearance is both "adenosarcomatous" and fibrosarcomatous. ×75.

ably in a para-articular bursa. Histologically it is composed of dedifferentiated fibrosarcoma-like tumor and completely differentiated endothelium-like spaces. Intermediate reticulo-endothelial features appear lacking.

Clinically, we believe recurrence or metastasis will undoubtedly occur unless the patient accepts further therapeutic measures.

CASE 3. Synovioma of olecranon bursa; treatment by local excision.

C. V., female, aged 50 years, a housewife, was admitted to the second Surgical (Cornell) Division of Bellevue Hospital, in November, 1939, complaining of a lump on her left elbow of 10 years' duration. In the last 10 days, however, it had grown in size and had become red, inflamed, and tender.

Examination revealed over the posterolateral aspect of the left elbow a large mass 4 by 5 by 6 centimeters which was firm, red, inflamed, and slightly warm. The mass was fluctuant at its apex. Clinical diagnosis was an inflamed olecranon bursa.

Patient was treated with wet dressings, after which on November 20, 1939, through a simple incision, the tumor was exposed and easily dissected free from the overlying skin. It was firmly attached to the underlying joint capsule and triceps fascia. The tumor was irregular, firm, partially fluctuant, and extended over the radial head of the elbow joint.

When pathological study revealed that the tumor was a synovial sarcoma, patient was asked to return for amputation but refused. In May, 1940, she returned with a local recurrence at the operative site, which was re-excised.

The original tumor was ovoid in shape, and measured 1½ by 1½ by 1¼ inches. The surface was nodular and covered by a thin fibrous capsule. On section the tumor presented a nodular fibrous consistence. In the center there was a cystic cavity about ¾ inch in diameter.

Sections revealed a thin capsule of lamellated connective tissue which was rather vascular and which varied in thickness in different locations. Continuous with the capsule and filling the center of the tumor mass, was a rather dense cellular overgrowth composed of closely packed cells with nuclei that were rounded, oval, vesicular, or reniform, and with prominent nucleoli. The nuclear membrane was sharp and distinct, the nucleus was pale, the nucleolus was generally black, but sometimes had a faint pink tint giving it the appearance of an epithelial or endothelial cell. Mitotic figures were fairly numerous, 1 or 2 per high power field. In many locations, there could be seen two general cell types: fasciculi of more elongated spindle-like cells and groups of more polygonal cells with rounded or oval nuclei. There were indefinite transitions between the two cell types.

In places the tumor was relatively acellular and the mass was subdivided by thick bands of calcified and ossified hyaline material which resembled fibrocartilage and connective tissue. There were also more delicate strands of pink-staining material surrounded by closely approximated tumor cells which had the appearance of an albuminoid deposit within the tumor. In a rare instance it was possible to identify irregular endothelium-like spaces within the tumor filled with a serous material and blood, and lined directly by cuboidal tumor cells. In a few areas the appearance was characteristic of fibrosarcoma with occasional large plasmodial giant cells. Mucicarmine stain revealed slender positive threads of mucin among the cells. Reticulum stain disclosed a uniform rich arborescent reticulum surrounding individual and groups of cells.

The tumor is fundamentally a reticulosarcoma composed of rounded and elongated elements both of which are reticulum positive. Endothelial evolution is revealed by some well formed gland-like spaces, but is less conspicuous than in Cases 1 and 2. Focal areas reveal fibrosarcomatous characteristics. Interstitial mucous production was prominent. Calcification and ossification were also observed.

Clinically, without amputation the prognosis is unfavorable.

CASE 4. Synovioma of right thigh probable origin in bursa overlying lesser trochanter; treated by local excision.

C. C., a 26 year old colored housewife, was admitted to the Meadowbrook Hospital on the service of Dr. Norman Treves, for a tumor of the inner side of the right thigh, of 9 months' duration. For the past 3 months, the mass had slowly increased in size and had caused occasional gnawing pain.

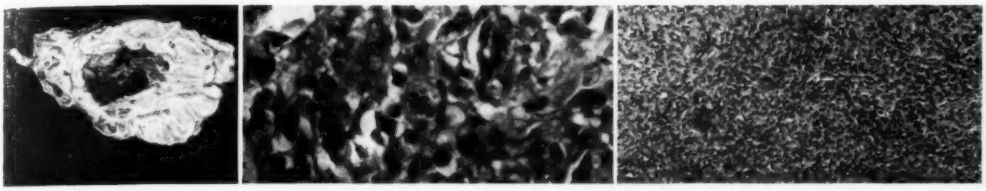

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Fig. 3. Case 3. a, Photograph of drawing of synovial sarcoma involving olecranon bursa, 7/12 actual size. b, Photomicrograph showing characteristic reticulosarcomatous appearance. ×235. c, Photomicrograph, reticulosarcomatous area of tumor. Other areas show characteristic gland-like spaces. ×60.

Examination revealed a firm, nontender, tumor mass about the size of an orange beneath the adductor muscles high up on the inner aspect of the thigh. A roentgenogram, January 19, 1940, showed a small mass on the upper end of the femur with a sharply outlined periphery of the same density as the muscle tissue. There was no evidence of bone involvement or of calcification.

A biopsy on January 23, 1940, resulted in a diagnosis of synovial sarcoma, and on February 17, 1940, a radical local excision of the tumor was performed. In spite of deep x-ray therapy the tumor recurred to its original size after a period of 3 months. Further data are not yet available, however, there is no doubt but that this case will terminate with generalized metastases.

Specimen was an encapsulated cystic tumor mass about 8 by 15 centimeters, which on section was friable and showed numerous xanthomatous areas which were revealed as yellow, circumscribed deposits throughout the tumor.

The microscopic features were quite similar to those in Case 1, with the addition that the histiocytic areas of the tumor could be shown undergoing evolution into large masses of xanthoma cells indistinguishable from those ordinarily found in benign xanthomatous giant cell tumor. In some areas the tumor was extremely fibrous and here the histological picture was similar to that of benign xanthomatous giant cell tumor, with the additional finding of islands of endothelial cells which assumed a gland-like pattern. With the reticulum stains the distinction between the endothelial and histocytic components of the tumor were more clearly demonstrated and the evolution of the reticulum elements into foam cells by a progressive lipophagic infiltration could be clearly shown.

Many areas showed a structure quite similar to that of a papillary adenocarcinoma, the papillary appearance reproducing synovial villi lined by cuboidal cells.

This case is most valuable from the histological viewpoint in that it demonstrates the widely varying cellular appearances that the tumor elements can assume. Dark-staining reticulum positive areas, pale endothelial areas, areas resembling papillary adenocarcinoma, and areas resembling benign xanthomatous giant cell tumor were all present. It also illustrates the fundamental histological identity of origin of the benign xanthomatous giant cell tumor which is essentially a benign histiocytoma and the malignant synovial sar-

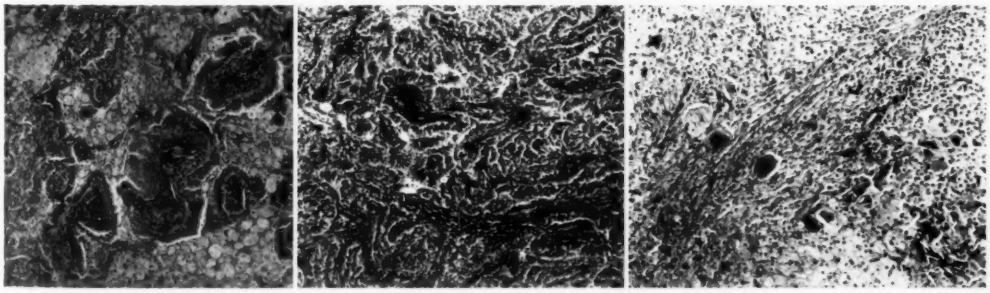

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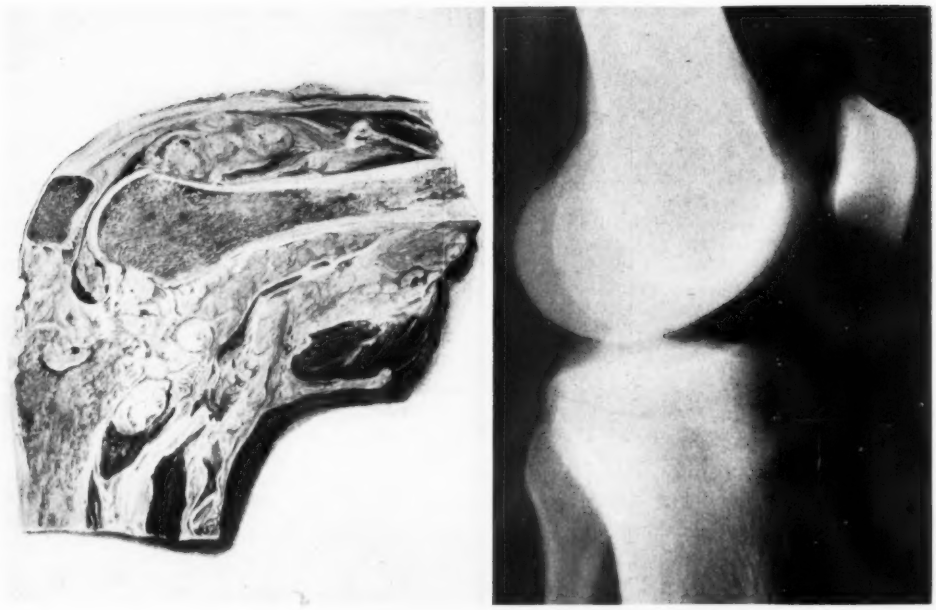
Fig. 4. Case 4. a and b, Photomicrographs. Note the papillary character of the endothelial cells of the tumor reproducing neoplastic synovial villi. Note also the epithelioSarcomatous character illustrated better in b and the xanthomatous transformation. The xanthomatous cells may be traced to the darker staining reticulum positive elements of the tumor, confirming their histiocytic nature. ×75. c, Another area of same tumor showing complete histiocytic differentiation scarcely distinguishable from that seen in benign xanthomatous giant cell tumor. ×63.



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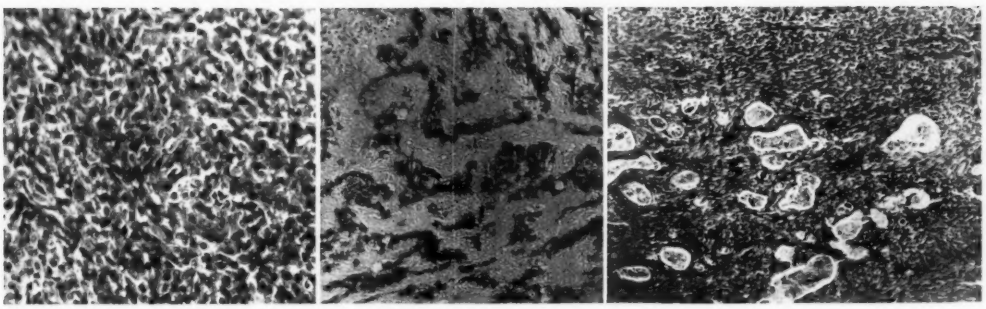


c d e

Fig. 5. Case 5. a, Photograph of drawing, approximately ⅓ actual size of specimen. Intra-articular synovial sarcoma showing tumor in joint space, suprapatellar pouch, infrapatellar ligament and popliteal space. Note that tumor has invaded the upper end of the tibia and the lower end of the fibula. b, Roentgenogram taken 5 years before amputation showing increased intra-articular soft tissue. c, Indifferent area of tumor essentially reticulosarcomatous in character. ×125. d, Similar area, Laidlaw stain. ×75. e, Photomicrograph of an area showing characteristic "adenosarcomatous" appearance, with the formation of gland-like spaces filled with mucin. ×65.

coma which is essentially a malignant reticuloendothelial sarcoma from synovial tissue.

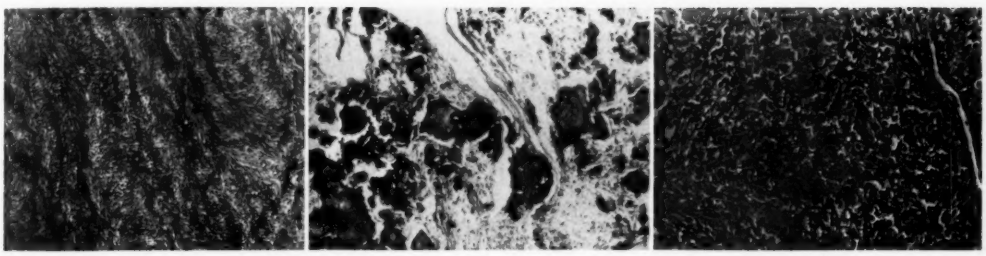
Case 5. Synovioma of left knee joint and suprapatellar pouch and popliteal space. Terminating, 13 months after amputation, in generalized and pulmonary metastases.

H. S., a 23 year old student, was first seen in the Hospital for Ruptured and Crippled, June 27, 1932, complaining of pain in the left knee for 18 months. Shortly before the onset he was hit in the left knee with a hockey puck. Pain was aggravated by motion or exercise.

Examination at that time was essentially negative except for slight limitation of extension.

A roentgenogram, June 28, 1932, Dr. Raymond Lewis reported revealed "no bony changes and the joint spacing seems normal and symmetrical. *There*

a



b c d

Fig. 6. Case 6. a, Roentgenogram of recurrent tumor showing focal calcification of soft part tumor. b, Typical dedifferentiated fibrosarcomatous area of tumor. ×75. c, Amorphous deposition of calcium. Compare with Figures 1b, 8b, 9c. ×65. d, Another area of tumor showing characteristic reticulosarcomatous evolution. ×65.

is a mottled increase in density of the soft tissues of the joint anteriorly below the patella."

A diagnosis of chronic traumatic synovitis was made and patient was treated by physiotherapy and strapping. He left the clinic, however, and consulted various physicians who treated him for arthritis. One year later *he was operated upon at another hospital with a diagnosis of dislocated semilunar cartilage.* This operation resulted in no improvement of the intense pain. In February, 1937, he presented himself with a large swollen left knee. Roentgenograms were inconclusive. The knee joint was explored and a tumor was encountered in the suprapatellar pouch. On February 9, 1937, an amputation at the junction of the upper and middle thirds of the thigh was performed for synovial sarcoma. Roentgenogram of chest at the time was negative for metastases. After amputation, patient was given 7 injections of Coley's toxin.

On May 25, 1937, a chest x-ray film disclosed many metastases scattered through the lungs. He gradually weakened and died on March 15, 1938.

A fusiform swelling involved the entire region of the knee for about 6 inches above and below the joint. On sagittal section of the amputated extremity there is found a soft area of new-growth which apparently has its origin in the synovial membrane of the knee joint in its posterior aspect, and which extends into the suprapatellar pouch anteriorly and posteriorly for about 2 inches, invading the soft tissues of the popliteal space. It also invades the upper end of the tibia and the lower end of the femur.

Microscopic sections show a tumor composed for the most part of large rounded and blunt spindle cells with pale oval vesicular and reniform nuclei. The cells suggest endothelium in their general appearance and arrangement. The tumor for the most part is diffuse and compact, but in places the arrangement is loose and the tumor reproduces gland-like, irregular spaces filled with mucoid fluid. Elsewhere the cells are slightly elongated and spindle shaped, suggesting spindle cell sarcoma. In a few places it

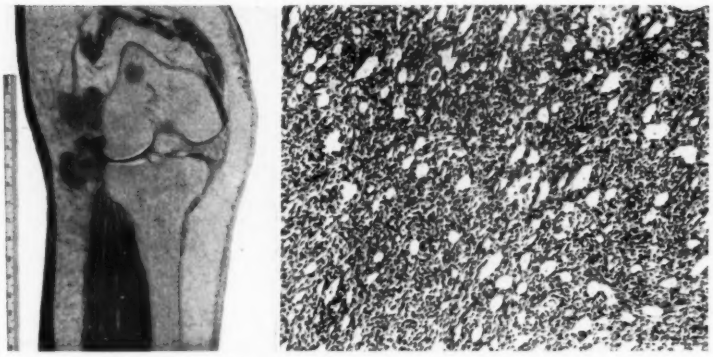


Fig. 7. Case 7. a, left, Photograph of coronal section of amputated specimen, somewhat reduced. Note that the internal semilunar cartilage has been removed. The bulk of the tumor is in close apposition to the joint. b, Photomicrograph of a characteristic "adenosarcomatous" area of tumor. ×75.

is possible to trace the tumor to a lining synovial layer of cells. There are areas which show stream-like invasion of joint capsule and ligamentous structures. There is no tendency to reproduce cartilaginous or osteoid elements. A few large collections of typical xanthoma cells are also found. Sections of femoral condyle and upper tibia show replacement by similar areas of tumor. Mucicarmine stains fail to reveal the presence of mucin. With Laidlaw's reticulum stain two cell types can be distinguished. Clear negative areas correspond to the more rounded cells, and numerous positive fine threads of reticulin correspond to the more elongated cells.

Diagnosis: Synovial sarcoma (synovioma).

Histologically, Case 5 is essentially similar to Cases 1, 2, 3, 4. The endothelium-like areas are less numerous but are most typical and correspond to those in the classical descriptions of Stuer and of Lejars and Rubens-Duval.

The pre-operative duration of symptoms in this case was 6 years. Pulmonary metastases appeared 3 months after amputation and death intervened 13 months after amputation. In spite of an exploration of the knee joint in 1933 the possibility of synovial sarcoma was not considered. The tumor showed bone invasion of great extent.

Case 6. Synovioma of left lateral knee, probable origin in bursa of vastus lateralis. Treated by two local excisions. There has been no second recurrence after 1 year.

This patient, G. B., was admitted to the Hospital for Ruptured and Crippled on August 26, 1938, complaining of a painful mass on the left leg. He states that 3 years ago, while playing baseball, he was "spiked" on the lateral aspect of his left knee with the shoe of another player. There was slight swelling and pain about the knee, and it was treated by hot applications until the symptoms disappeared. Three months later the pain and swelling recurred. These symptoms gradually increased during the next 8 months and at that time, 11 months after the injury, he consulted a physician. X-ray films were made and he was admitted to another hospital where a tumor was excised, involving the "semimembranous musculature and leading back to the popliteal space."

Pathological examination described a tumor measuring 5 by 2½ by 1½ centimeters, having the consistence of soft bone. On microscopic section, it showed incomplete ossification and calcification imbedded in hyalinized connective tissue. A few osteoblasts were scattered about the osteoid spicules. The final diagnosis was a benign osteoma.

Patient was free of pain for 3 months, after which it recurred, and gradually increased. The mass also recurred, growing slowly during the past year.

Examination revealed a well developed and nourished male of 22 years. There was a prominence on the lateral aspect of the left thigh immediately above the knee joint where a well defined tender tumor 7 by 7 centimeters could be felt. It was not attached to the skin but was attached to the deep structures.

X-ray films revealed a soft part tumor lateral to the knee joint, containing irregularly distributed lime. There was no evidence of primary bone or joint involvement. Chest plates were negative.

On September 16, 1938, the patient was again operated upon and a tumor was exposed lying within the substance of the vastus lateralis muscle and apparently extending to the capsule of the knee joint. The tumor was excised, including much of the vastus lateralis muscle and some of the capsule.

The specimen was a flat, white, fibrous mass measuring 5 by 3 by 2 inches with some adherent semimembranosus muscle composing the edges. On sec-

Fig. 8. Case 8. a, left, Roentgenogram of recurrent calcified soft part tumor in popliteal space. b, Photomicrograph of area of fibrosis and calcification. Synovial sarcoma was not suspected until recurrence took place. The recurrent tumor is histologically identical with that in Figure 5c. ×78.

tion, it was found to be of tough fibrous consistence with some areas appearing soft and fish-like. Other areas appeared bony hard in consistence.

Large numbers of blocks of this tumor were studied in the attempt to establish the exact type of sarcoma. In many areas the tumor presented the typical appearance of common fibrosarcoma, that is to say, it was composed of elongated spindle cells and elongated fibrils in a wavy fascicular arrangement. In other areas, the tumor exhibited interstitial deposits of amorphous calcium present as small and large granules which could be seen undergoing various stages of chondrification and ossification. About these areas there was a peculiar albuminoid impregnation of the stroma resembling somewhat the preosseous infiltration of osteoid tissue and identical in appearance with areas of Cases 1 and 9.

Preparations of the soft fish-like areas showed a tumor of entirely different aspect. Here the tumor was composed of a syncytium of cells with pale, oval nuclei with a definite nuclear rim and a prominent nucleolus. In some areas the tumor elements could be seen grouped about small blood vessels. In a few areas the arrangement of the cells was pseudoglandular and here they could be seen forming gland-like spaces. This arrangement was definite, although it could be located only exceptionally.

In these highly cellular areas, it was possible to trace the tumor to a definite synovial border, which resembled a hyperplastic rather than a neoplastic synovial membrane. The cells along the border were flattened, but beneath the border there were fairly numerous, pale, oval nuclei which were difficult, if not impossible to distinguish from the endothelium-like tumor elements present in the deeper tissues. Mucicarmine and reticulum stains of soft cellular areas showed anastomosing mucin threads and a rich fine arborescent reticulum around almost every cell.

A diagnosis of synovial sarcoma was made and the patient was advised to have an amputation but refused.

A report obtained October, 1939, indicates that the patient is working and apparently in good health. It is our belief, however, that, without further treatment, dissemination of the disease is inevitable.

The bulk of this tumor resembles a common fibrosarcoma of moderate malignancy (grade 1). Areas of calcification, albuminoid infiltration of the stroma lead to a suspicion of synovial sarcoma. Soft areas of tumor sectioned revealed sheets of pale endothelium-like cells, synovial borders, and occasional gland-like spaces as well as intercellular threads of mucin. The specificity of the tumor was thereby assured. This case closely parallels one quoted by Berger as occurring in Sabrazes' laboratory in which (footnote p. 534) the original tumor was identical with that in our Case 1 and Berger's Case 2, and the recurrence was indistinguishable from common fibrosarcoma. Calcification and albuminoid impregnation, though not entirely specific features of synovial sarcoma, are helpful in arriving at the diagnosis. Areas of reticulo-endothelial evolution although not so well developed as in Cases 1 and 2, are none the less strikingly dissimilar to the fibrosarcomatous areas.

CASE 7. Synovioma involving right knee joint, popliteal space, and biceps femoris tendon; treated

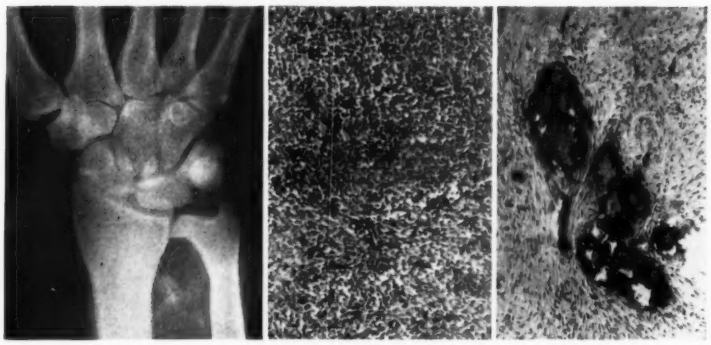


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Fig. 9. Case 9. a, Roentgenogram of tumor of wrist. b, Reticulosarcomatous area. ×52. c, Another area showing calcification of tumor. ×52.

for 2 years as internal derangement of knee joint, later by amputation. Alive with pulmonary metastases after 2½ years.

E. S., a Jewish housewife aged 37 years, was referred to the New Haven Hospital on January 11, 1937. She first noticed pain in the knee in the summer of 1934 and in January, 1935, after having wrenched her right knee in an automobile accident, the pain had become worse. A diagnosis of rupture of the external semilunar cartilage was made, *and on January 30, 1935, the joint was explored and the internal semilunar cartilage was removed.* In August, 1935, she was readmitted to the hospital where she remained until September for correction of a flexion contracture by a wedge cast. In January, 1936, she was readmitted and a second arthrotomy performed. A mass of necrotic granulomatous material was removed from the external posterior aspect of the cartilage and reported as follows:

"Pathologically the specimen was received in several small pieces, the largest one measuring 2.5 by .5 by 1 centimeter. On section these pieces presented a homogeneous cartilaginous structure. The microscopic sections showed cells of cartilage type. No evidence of any abnormal pathology could be found. The diagnosis was cartilaginous proliferation."

Roentgenographic examination of the joint in January, 1935, was reported negative. Roentgenographic examination in December 11, 1936, showed marked narrowing of the joint space, *some moderate proliferation about the margin of the joint*, and rather marked bone atrophy. Stereographic examination of the chest for metastases was indeterminate.

Physical examination revealed that "the patient's right knee was held at about 30 to 35 degrees' flexion. Motion was extremely difficult to obtain. There was considerable periarticular thickening. There were two operative scars, one over the lateral and anterior aspect of the joint centering on the joint line, and another overlying the lateral hamstring, above the lateral condyle. *About the center of the scar crossing the joint line there was an extremely sensitive nodule about 1.5 centimeters in diameter apparently attached to the capsule*, but so sensitive that it could not be satisfactorily palpated for mobility. *There was a second movable nodule just above the head of the fibula* apparently attached to the deep fascia. The third nodule was found medial to the external hamstring and firmly attached to the deep fascia. There were no enlarged inguinal lymph nodes.

A biopsy of one nodule was made and revealed the presence of a sarcoma of synovial origin. On February 8, 1937, a midthigh amputation was performed. Examination of the amputated extremity showed a large tumor mass involving the knee joint and extending into the popliteal space. The patient has been followed since discharge from the hospital. In December, 1939, she developed a cough and chest pains. Roentgenograms of the chest revealed extensive pulmonary metastases.

This case like the one reported by Hodgson showed a skin metastasis. The long history of joint disability suggests a primary origin in the joint synovial membrane with outward spread to popliteal space and biceps tendon. In spite of two explorations, the nature of the disease was not recognized. The degenerated tissue removed at second operation was probably necrotic tumor tissue unsuitable for recognition. Clinically the difficulty of diagnosis is similar to that encountered in Cases 2, 10 and 11. Histologically, this case is identical with Case 5.

CASE 8. Synovioma of left knee joint and popliteal space, symptoms of 6 years' duration. Treated by local excision, deep x-ray therapy, and delayed amputation. Death from pulmonary metastases 2½ years after amputation.

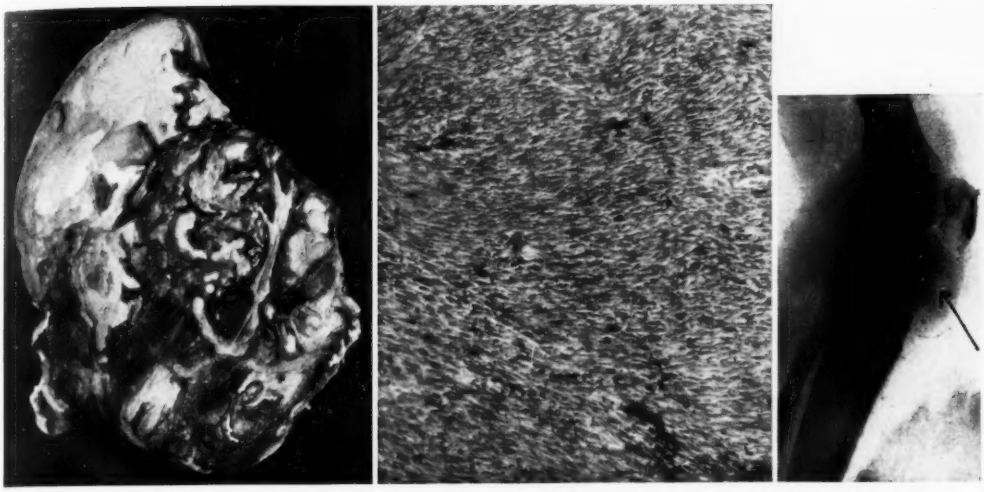

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Fig. 10. Case 10. a, Photograph of drawing, ⅓ actual size, large intra-articular synovial sarcoma of knee joint. b, Photomicrograph of indifferent fibrosarcomatous appearance, dark areas represent hemosiderin pigmentation. ×100. c, Roentgenogram showing large intra-articular soft part tumor.

L. M., a student, aged 24 years, entered the Hospital for Ruptured and Crippled, October 16, 1935, complaining of pain and stiffness in his left knee of 6 years' duration. Six years ago, after falling down a flight of stairs, he injured the knee and following this, he had some swelling. A short time later he was kicked in the left knee and since then he has had pain and discomfort on the lateral aspect, which has grown steadily worse during the past 4 years.

Examination revealed a tender swelling over the lateral aspect of the knee joint. Flexion and extension were limited by about 15 degrees.

Roentgenograms showed a large irregular calcified body lying posterior to the lateral femoral condyle. This body dipped medially and forward into the intercondyloid notch. At the front of the joint opposite this projection there appeared a good sized oval body with an irregularly calcified periphery and a clear central area.

A clinical diagnosis was made of "calcified popliteal cyst," and on November 4, 1935, the mass was exposed through an incision over the outer side of the left knee. The outer portion of the gastrocnemius was cut and the popliteal space was exposed. From this area, the mass was found to extend forward into the posterior aspect of the knee joint.

The specimen was an encapsulated fibrous mass roughly ovoid in shape, measuring 3 by 2 by 2 inches. Adherent to the capsule there were some loose tags of fibrous tissue. On cross section it was found to be fibrous with nodular areas of cartilaginous and osseous consistence.

Microscopic examination at this time disclosed a fibrocellular tumor scattered throughout which there were numerous amorphous deposits of calcium, many of which could be seen undergoing metaplasia into cartilage and bone. The stroma in places, was extremely hyaline and fibrous and throughout it were scattered pale oval nuclei which were interpreted as being chondroblasts because they were found lying in a medium resembling fibrocartilage. In addition, there was impregnation of the stroma by a hyaline albuminoid material which could not be positively identified, but which resembled pre-osseous infiltration of fibrous callus. Histologically, this was identical with that found in Cases 1 and 6. In some areas, the aspect was myxomatous being composed of a loose meshwork of stellate cells in delicate fibrils. In other areas, the aspect was fibrocellular, being composed of elongated spindle cells in a collagen-like stroma throughout which were scattered granules of intracellular and extracellular hemosiderin pigment. At that time the possibility of malignancy was not seriously entertained, and the mass was considered to be a calcified popliteal bursa.

Eleven months later, in October, 1936, he complained of a recurrence of his symptoms. Roentgenograms taken at this time revealed an oval soft tissue mass at the back of the joint, with some irregular, scattered, surrounding calcification. The mass seemed to be outside the joint.

Because of the recurrence, the original slides were reviewed. It was then thought that they represented some unusual form of synovial sarcoma. Patient was given deep x-ray therapy without improvement and after 6 months, amputation was advised.

Shortly thereafter he consulted a surgeon in Boston, who excised the recurrence which was found to

be frankly malignant and proposed amputation, which the patient accepted.

Amputation of the left leg at the midthigh was performed at the Massachusetts General Hospital, February 13, 1937. The pathological report is furnished by Dr. Tracy Mallory:

"February 13, 1937 B. M. 14342

"Diagnoses: Myositis ossificans
Sarcoma, type undetermined, (?) synovioma.

"Femur. Gross. A left leg amputated at the mid thigh. The knee is markedly limited in motion owing to a large tumor mass of bony consistency which fills the popliteal space and extends over the lateral surface of the joint and the lower end of the femur. Overlying the tumor is a crescentic healed operative incision 6 centimeters in length. This lies approximately in the center of a circular area of erythema and tanning due to recent radiotherapy. After turning back skin flaps and careful dissection, a large tumor mass is finally dissected free. Though an apparent plane of cleavage between the tumor and the joint capsule is found, further investigation shows that the posterior portion of the joint capsule is diffusely infiltrated with tumor and measures 2 centimeters in thickness. The lower border of the tumor is fairly well delimited. It extends beyond the joint and a thumb-like projection of soft tumor extends down almost to the head of the fibula. The upper margin is impossible to determine, the tumor infiltrating fibrosed atrophied muscles very widely. A fasciculus of muscle fibers about 1 centimeter in diameter extends upward to within 1.5 centimeters of the line of amputation which is white, partly fibrous, partly gelatinous, and contains granules of calcium. On section the central part of the tumor consists of cyst-like cells 1 to 1.5 centimeters in diameter of calcified material, apparently bone, each of which encloses a central mass of pearly, myxomatous tissue readily expressed by slight pressure. The peripheral parts of tumor show an intermixture of white fibrous tissue with the myxomatous material and only rare, gritty granules. An occasional area shows a frank "fish-flesh" character over an extent of 1 to 2 cubic centimeters.

"Microscopic. The appearance of this tumor is as unusual as the gross. The tumor proper consists of infiltrating strands and masses of very uniform small cells with oval nuclei and a scant neutrophilic cytoplasm which is occasionally drawn out into a short spindle. There is a tendency to fascicular grouping and also to whorl formation. Practically no collagen is present between the tumor cells except in the immediate neighborhood of blood vessels and capillaries, and it is improbable that the tumor cells are producing it. No fibrils are demonstrated with phosphotungstic acid hematoxylin. Despite the extreme cellularity, mitotic figures are astonishingly infrequent. The tumor is invading fibrous tissue and muscle bundles. Scattered irregularly through it are bony islands, occasionally with a trabecular architecture. Many appear inactive, but others are bordered by osteoclasts and osteoblasts and show both lacunar resorption and also osteoid borders. The cartilage shows both sharply circumscribed islands of inactive hyaline cartilage and also transitions from cartilage through mucinous tissue to ordinary fibrous tissue. No relation whatever between this bone and cartilage formation and the tumor cells can be made out. The appearances suggest an old focus of myositis ossificans invaded by a new and entirely independent malignant tumor. The nature of this new malignant tumor is by no means clear. Neurogenic fibrosarcoma, endothelioma, and synovioma are possibilities. In spite of the absence of epithelium-like cells, the latter seems the most probable. It also offers the worst prognosis."

In February, 1939, x-ray films showed definite pulmonary metastases. The patient died September 4, 1939, of pulmonary and generalized metastases. No autopsy was permitted.

Clinically, the pre-operative duration of symptoms was 6 years. The interval from onset to death was 10 years. Death occurred 2½ years after amputation and approximately 4 years after first local excision.

A comparison of the tumor with a previous case, Case 5, shows essentially the same round and spindle cell characteristics. Reticulum staining of the old blocks was unsatisfactory due to the age of the material. However, it was impossible to identify gland-like grouping of the cells. The identity with the previous case and other cases together with the localization and clinical course leave no doubt that this is a true example of synovial sarcoma. The calcification, chondrification, ossification, and albuminoid infiltration are identical with Cases 1 and 6. The histological identity of the tumor cells with that of Case 5 is further proof of the synovial origin of the tumor.

CASE 9. Synovioma of left wrist region, treated by local excision. No recurrence within 9 months.

A. S., a housewife, aged 34 years, complained of a slowly progressive swelling of the anterior surface of the left wrist of 6 years' duration. There was no history of pain or trauma.

Examination disclosed a swelling of the anterior and dorsal surfaces of the left wrist overlying the distal end of the radius and ulna.

An x-ray film on March 28, 1939, showed a quite sharply defined rounded soft tissue tumor mass situated between the radius and ulna. This started just above the lower radio-ulnar articulation and extended up the forearm for a distance of about 4 centimeters. It bulged both anteriorly and posteriorly, and it contained a rather irregular deposition of lime. There appeared to be a certain amount of pressure atrophy of the lower ulnar shaft.

X-ray diagnosis: Probably synovioma.

The patient was advised to enter the hospital for excision, but rejected this advice. She did, however, enter another hospital on March 30, 1939, where the tumor was excised.

The specimen consisted of a circumscribed tumor mass occupying a volume of about 4 centimeters in diameter. On section some areas of this tissue were found to be soft, and presented a homogeneous gray, waxy appearance. Other portions of the tissue contained small spicules of bone. In the main the tumor was composed of a homogeneous gray, waxy appearing tissue with occasional soft necrotic appearing areas.

One of the slides of the microscopic sections showed a densely cellular overgrowth of blunt spindle cells with somewhat rounded nuclei and poorly visible cytoplasm. The cells were compactly arranged somewhat in the manner of epithelial cells, and here and there one noted a mitotic figure among the nuclei. In places the arrangement was whorl-like, elsewhere there were areas in which the cells were loosely arranged. In these areas the cells were frequently vacuolated and presented a pseudomyxomatous appearance. In addition, there was a tendency to form slit-like spaces with an endothelial lining, and finally, in other areas the structure was highly fibrous, the cells assuming an elongated spindle appearance which resembled that seen in fibrosarcoma. Here the stroma was abundant, and the cells were not numerous, and there was considerable calcium deposition—the calcium appearing as coarse fragments. One small area shows actual bone formation. In general, the tumor exhibited a varied histological appearance and ranged in its appearance from a fibrosarcoma to areas which resembled a reticulum cell sarcoma.

Examination and x-ray film of the wrist in November, 1939, showed no recurrence of the disease.

CASE 10. Synovioma of right knee joint. Treated by repeated local excision, deep x-ray therapy, and delayed amputation. Death 10 years after amputation, of pulmonary metastases. This case was reported in detail by Dr. Lewis C. Wagner and represents the first synovial sarcoma to be reported in the American literature. Follow-up data not then available are now furnished.

H. N., a 35 year old musician, with an irrelevant family and past history, without any apparent cause, began to complain about 10 years ago of pain in the right knee. It was treated with the usual rheumatic treatment by the family physician but with no improvement. In the summer of 1923 he consulted a surgeon and the limb was immobilized in plaster without relief. The patient entered the hospital in October, 1923. Examination showed him to be in good health but he was walking with a slight limp, although the functions of the right knee were not impaired. There was a slight fullness under the right patella tendon. He brought a report of x-ray findings, which were normal. The case was thought to be one of chronic synovitis, and was treated conservatively with cautery and strapping. He did not improve but, rather, the pain became worse. In January, 1924, an x-ray picture was taken, which showed a mass behind the patella tendon that was thought to be hypertrophied synovial tissue. A definite tumor was not considered but on looking back, it was easily recognized. On February 13, 1924, the patella was split and the knee joint exposed. A solid tumor covered by a synovial veil lay in the knee joint. It was attached to the outer antero-inferior border of the capsule by a small attachment. The tumor measured 7 by 5 by 3 centimeters, was elliptical in shape, and surrounded by a definite capsule.

The patient was free from pain for 1 year when the tumor reappeared on the lateral surface of the knee. An extensive resection of the capsule of the joint was done and the patient was again free from symptoms after the second operation. He received extensive x-ray therapy and a thorough course of Coley's toxin. In 1926 the symptoms and signs reappeared. The tumor had invaded the upper end of the tibia, under the patella tendon. Resection was unsatisfactory at the third operation and 2 weeks later a midthigh amputation was done.

Examination March, 1930, showed the patient well and free from recurrences or metastases. In 1936, the patient succumbed from pulmonary metastases.

Through the courtesy of Dr. Francis Carter Wood, we were permitted to re-examine a slide which for the most part resembled a common fibrosarcoma. This tumor represents a dedifferentiated synovioma showing predominant fibrosarcomatous characteristics. On the authority of Drs. Ewing and Wood who examined many sections removed at the time of operation, it is included as an undoubted synovioma. Many areas show coarse clusters of intracellular hemosiderin pigment. Multiple sections and special stains could not be employed because the operative material was no longer available.

CASE 11. Synovioma of left knee joint and suprapatellar pouch, treated by two local excisions and delayed amputation. Death from pulmonary metastases.

R. L., a white Hebrew male, aged 25 years, was first seen in the New Haven Hospital in July, 1935, when he complained of pain and swelling in his left knee which he said developed following a baseball game. The patient had a history extending 6 or 8 years prior to this admission, when he noted that flexing the knee resulted in pain which could be eased by extending the leg. In the summer of 1934 the knee suddenly became swollen. No definite diagnosis was made and physiotherapy was instituted without improvement.

Throughout the summer of 1935 the patient continued to suffer pain and swelling. On this admission, roentgenograms were taken but no definite diagnosis was made. Upon review of these original films a definite suprapatellar tumor could be seen. After several days in the hospital the swelling gradually subsided and he was discharged to the ortho-

Fig. 11. Case 11. a, Original roentgenogram showing tumor in suprapatellar pouch, overlooked at time of first examination.

pedic dispensary. The diagnosis at that time was considered to be traumatic arthritis with a possible ruptured medial meniscus. Finally, in March, 1936, he was advised to come into the hospital for operation.

Physical examination of the left knee revealed a slight fluid swelling of the joint. In the suprapatellar region a hard freely movable mass about 5 centimeters in diameter could be palpated. There was no limitation of motion except on flexion, and this was painful at 90 degrees. Some atrophy of the left thigh was evident.

On March 23, a tumor of the left quadriceps pouch was excised.

The patient was discharged April 7, 1936, on crutches. On July 30, 1937, a roentgenogram of the knee revealed a recurrent tumor of the quadriceps pouch. The patient was seen subsequently in Baltimore where he was reoperated upon in October, 1937. At that time tumor tissue was removed from the suprapatellar and popliteal regions.

The patient subsequently returned to New Haven with several draining sinuses and with evidences of recurrent tumor. A course of deep x-ray therapy delivered through three ports, a medial, lateral, and posterior, about the left knee with 1890 roentgen units through each port, was given without improvement. In February, 1938, an amputation of the leg was performed.

The patient died at home on December 7, 1938, of pulmonary and generalized metastases.

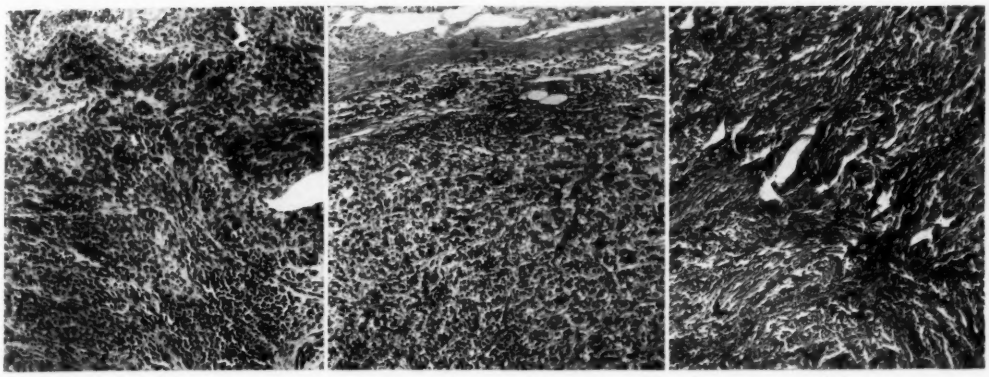
The specimen removed March 23, 1936, is a discoid shaped mass of firm pink gray tissue which measures 7 by 5 by 2.5 centimeters. The external surface is irregular except on one side where it appeared smooth and shiny. The cut surface is composed of whorls of dense gray-white tissue.

Microscopic sections show the mass to be composed of a hyalinized connective tissue stroma embedded in which, in a haphazard fashion, are masses and strands of atypical cells. These vary from spindle to polyhedral in shape and have ill-defined cell outlines. The predominant cell is polyhedral in shape with a small amount of pink staining cytoplasm and vesicular nuclei. Moderate numbers of these cells are in mitotic division. In many places the cells are arranged about slit-like lumina with a layer of these cells lining the lumen. In other places the cells are arranged about spaces lined by flattened endothelial cells which appear to be blood vessels. Scattered throughout the section in many of the masses of cells are occasional multinucleated giant cells. One edge of this section has a smooth, undulating synovial border which is lined by a flattened layer of cells. Subjacent to this surface are masses of polyhedrally shaped tumor cells. This apparently represents the region of the tumor in contact with the suprapatellar pouch.

Histological sections of the recurrent tumor removed from the knee joint in October, 1937, showed a structure similar to that of the original tumor.

The specimen removed February, 1938, is the amputated leg which has previously been dissected at another hospital. The soft tissue has been removed from the bony framework. In the area over the patella, there are two longitudinal healed scars and in the popliteal space there is another scar which is incompletely healed. In its central portion a sinus communicates with the joint space. The articular surfaces of the joint are almost completely destroyed and have a dull, granular, mottled yellow and red appearance. In the popliteal space are a few somewhat irregular but fairly discrete nodules of a mottled gray yellow tumor tissue. Some of these appear to be lymph nodes which are invaded by tumor.

Microscopic section through the sinus tract shows the surface covered by exudate of polymorphonuclear leucocytes beneath which there is a mass of granulation tissue infiltrated with lymphocytes, large mononuclear phagocytes, plasma cells, and polymorphonuclear leucocytes. The articular surfaces of the joint are destroyed and involved by this inflammatory process which extends into the underlying bone. There is no tumor in the joint but adjacent to the sinus tract are several nodules of tumor which infiltrate the connective tissue. The tumor is made up of spindle and polyhedral cells which are arranged in masses and strands throughout a connective tissue stroma. The cells are variable in size and are basophilic staining. Numerous cells are in mitosis. Only occasionally do masses of these cells line up about slit-like spaces where they are arranged



b c d

Fig. 11. Case 11. b, Photomicrograph of a representative area of tumor showing histiocytic evolution, not unlike benign tumors of tendon sheath origin. ×68. c, A metastasis of the tumor in a popliteal lymph node. ×68. d, An area of recurrent tumor illustrating its dedifferentiated fibrosarcomatous character. ×68. Consult Figure 6b.

several layers deep in a somewhat palisading fashion. Several popliteal lymph nodes are replaced almost entirely by tumor tissue. Here the tumor has an epithelial character. Strands and masses of small polyhedral and spindle (almost column-shaped) cells are arranged in a delicate connective tissue stroma. Again slit-like spaces lined by several layers of these cells are occasionally seen and in some places there is a suggestive papillary arrangement of the cells. The tumor in this specimen appears less well differentiated than in the first two, but still maintains the characteristic features. The rate of proliferation is also enhanced as indicated by the increased numbers of mitoses.

Clinically, this case illustrates the long preoperative course of the intra-articular synovial sarcomas. Pathologically many areas resembled the "giant cell" tumors of the tendon sheath type similar to that in Cases 12 and 13. A number of pathologists reviewed the slides on this case and regarded it as a benign giant cell tumor. On the basis of areas exhibiting reticulo-endothelial characteristics similar to that of previous cases it was regarded as malignant.

CASE 12. Synovioma of superficial flexor tendon of fourth right finger treated by local excision, deep x-ray therapy, and delayed amputation.

E. S., a 32 year old housewife, noticed, in August, 1937, that the ring finger of her right hand was becoming stiff. This gradually progressed until it became painful to move the finger. About the middle of September, 1937, she noticed a slight swelling over this tendon which slowly increased in size. In October, 1937, she consulted a physician, who diagnosed an early Dupuytren's contracture, and prescribed short wave diathermy. In February, 1938, the small tumor was excised and submitted for histological examination. The histological diagnosis was "synovioma." Since that time she has received 22 x-ray and 2 radium treatments.

On examination, the ring finger of the right hand showed an x-ray dermatitis with some sloughing and ulceration. There was little function of the finger and an ulceration over the palmar aspect of the right ring finger at the region of the proximal metacarpophalangeal joint.

Examination of the first tumor showed that it was composed of polyhedral and polygonal cells bearing a striking resemblance to epithelium. The cells were present in compact masses which were generally enclosed in delicate trabeculae of connective tissue. The nuclei were pale, oval, or vesicular. The nucleolus was prominent. Mitotic figures were not observed. In other areas the tumor cells appeared elongated, spindle in character, and assumed the character of tumor fibroblasts. The cytoplasmic boundary was distinct and the cytoplasm was pale, sometimes vacuolated, sometimes translucent. There was no resemblance to xanthoma and giant cell tumor. Some areas resembled the tumor reported by Black, but it was impossible to use differential staining methods in the study of this tumor.

Amputation of the right hand and middle third of the right forearm was performed by Dr. Bradley L. Coley on May 10, 1938.

The specimen was a right hand and forearm amputated through the distal third of the forearm. On the palmar surface between the fourth and fifth fingers, there was an irregular ulceration about 2 millimeters in depth. On sagittal section through this area there was found an irregular zone of white tissue resembling tumor tissue, which implicated the tendons and extended down to the metacarpal joint of the fourth finger.

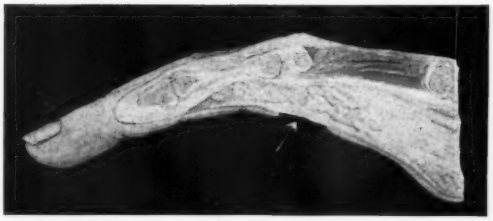


Fig. 12a.

Fig. 12b.

Fig. 12. Case 12. a, Recurrent synovial sarcoma of fourth flexor tendon. Skin ulceration produced by intensive irradiation therapy. b, Photomicrograph showing histiocytic evolution of tumor similar to that in Figure 11b. ×110.

In the slide of the recurrence there was considerable modification of the tumor, probably as the result of the intensive irradiation. Here the tumor was sparse in a loose fibrous stroma and was composed of syncytium of markedly degenerated spindle and irregularly shaped cells with indistinct cytoplasmic borders. In many areas where the nuclei were better preserved they had the same pale, oval epithelium-like aspect encountered in the primary tumor. Elsewhere they were shrunken and irregular. Here the tumor was robbed of any specific synovial characteristics. It could be traced, however, into the substance of the flexor tendon establishing its point of origin. Section through the base of the underlying metacarpal bone shows no evidence of infiltration by tumor.

In December, 1939, patient had no evidence of generalization and was free of symptoms of disease. Chest roentgenograms at this time were negative.

Black's tumor was apparently benign, although there was only a 10 month period of follow-up, which seems inadequate to assure the benignity of the tumor. We regarded this tumor as malignant. Black subsequently reported a synovioma of the great toe and added additional follow-up information of his first case occurring in the finger, indicating that the course after 2½ years was still that of a benign tumor. It may well be that small synoviomas in the tendons of the finger may run a more favorable course than the larger tumors about the larger articulations.

Case 13. Synovioma of left popliteal space, probable origin in semimembranosa tendon sheath, treated by two local excisions; well 2 years later.

H. B., male, aged 48 years, was admitted to another hospital, on July 23, 1937, with a history of a mass in the left popliteal space and slight stiffness of the knee joint for 1 month.

Examination of the knee revealed a hard, round mass about 2 by 2 inches located just below and in the lower third of the left popliteal space. The mass was fixed to the deep tissues, but not to the skin.

X-ray film of the left knee in the anteroposterior and lateral views showed a circumscribed tumor approximately the size of an egg, in the popliteal fossa. There was no destruction of adjacent bones.

On July 23, 1937, through a transverse incision over the most prominent part of the mass, a firm circumscribed tumor was dissected out of the popliteal space. Sharp dissection was required to free it from the tendon sheaths and from the posterior capsule of the knee joint.

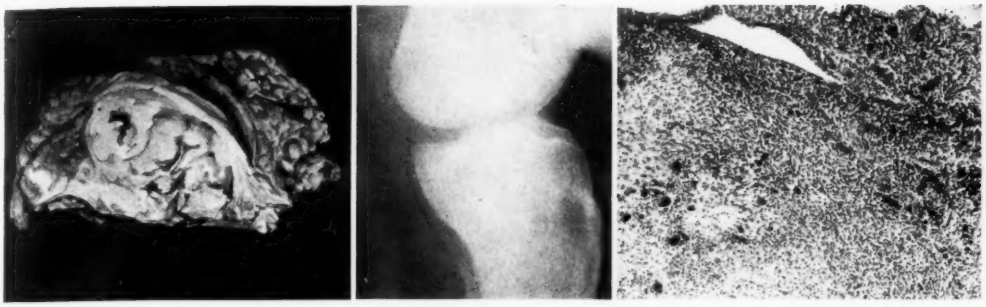
Pathological report, August 2, 1937. The tumor, from left popliteal space, was a pinkish-gray ovoid mass 6 by 4 by 5 centimeters in diameter with firm small tags of fat adherent to the surfaces. Fat tags and two or three almond shaped bodies which looked something like lymph nodes were adherent to the surface.

Histological examination showed that the stroma of the specimen consisted, for the most part, of polyhedral and spindle cells with large numbers of large multinucleated giant cells. Moderate numbers of tumor cells revealed the presence of hemosiderin pigment in the cytoplasm. Some of the tumor cells were large and contained lipoid substance.

Diagnosis: Giant cell sarcoma of tendon sheath (xanthomatous epulis).

Patient made an excellent postoperative recovery and was discharged on August 6, 1937. He was readmitted to the hospital on November 21, 1937, with a recurrence of the tumor.

Examination revealed a well healed scar, beneath which there was a firm, rounded mass in the medial



a b c

Fig. 13. Case 13. a, Photograph of drawing of specimen, ½ actual size. Note the clefts and the areas of pigmentation. b, Roentgenogram of original tumor in popliteal space. c, Photomicrograph of a representative area of tumor illustrating synovial border. The evolution of the tumor is histiocytic and essentially similar to that shown in Figures 10b and 11b. Note the multinucleated giant cells and the coarse deposits of hemosiderin to the right. ×65.

and posterior aspects of the left popliteal space, about 3½ by 1½ inches.

Through a vertical curved incision with the convexity toward the inner side, a tumor was exposed deep in the popliteal space. It was adherent to overlying muscles and tendons, and firmly adherent to the capsule. In removing the tumor it was necessary to remove a portion of the posterior capsule.

Pathological report. The tumor is circumscribed but does not have a distinct capsule. It measures 5 by 5 by 2 centimeters. Some loose tags of fibrous tissue are attached to the surface. On section the tumor cuts with a fibrous consistence and shows one fairly large cystic area about 1 centimeter in diameter. Scattered over the cut surface are firm, yellow, ground concentric nodules which have the consistence of cartilage. The intervening stroma is tinted in various shades from yellow to brown, the pigmentation being similar to that seen in xanthomatous giant cell tumor.

Because of the previous diagnosis of xanthomatous giant cell tumor, this tumor was studied by multiple section through a great many areas. The periphery of the tumor appeared largely encapsulated although the capsule was not complete. On superficial examination, there was found a striking dissemination of multiple deposits of intracellular hemosiderin pigment similar to that seen in xanthoma. Vast areas of the tumor presented a fibrocellular aspect, the cells being rounded, oval, blunt spindle, and irregularly shaped with oval and reniform nuclei. The arrangement of the cells was syncytial and this was better demonstrated by reticulum stains which showed both a fine and a coarse arborescent reticulum supporting the majority of the cells. In many of the areas, the stroma cells could be seen differentiating into multinucleated giant cells containing from 2 to 20 nuclei. In some fields giant cells were particularly numerous. Mitotic figures were fairly numerous about two per high power field. In many areas corresponding to the macroscopic concentric nodules, the stroma could be seen differentiating into fibrocartilage. With both hemotoxylin and eosin and Sudan III stains, *it was not possible to demonstrate lipoid in the tumor.* Along one edge of the tumor was a well defined synovial border probably that of the semimembranosus tendon. This border showed reduplication of the synovial border cells and multiplication of the subsurface cells with areas of blood pigment similar to hemorrhagic villous synovitis as described in the knee joint.

Throughout the main tumor mass were numerous synovial spaces lined by from one to three rows of polygonal and flattened cells, and these spaces contain a metachromatic mucoid substance.

This tumor represents a form of synovial sarcoma histologically closely related to the xanthomatous giant cell tumor. It has been referred to as the "tendon sheath" type. It differs from xanthomatous giant cell tumor in the presence of typical synovial spaces, the presence of circumscribed areas of fibrocartilage, and the rarity or absence of demonstrable xanthoma cells in the recurrence. No exception is taken, however, to the report of xanthoma cells being present in the original tumor. While the presence of foam cells is a striking feature of xanthomatous tumors histiocytic tumors are frequently found with little or no demonstrable lipoid. Berger in his Case 5 has reported what he regards as the first example of a malignant transformation of a xanthoma giant cell tumor in a white man 50 years of age, located in the anterior aspect of left thigh. This is identical with Berger's Case 5 showing synovial borders filled with blood pigment, classical giant cell features, and in original tumor, xanthoma cells.

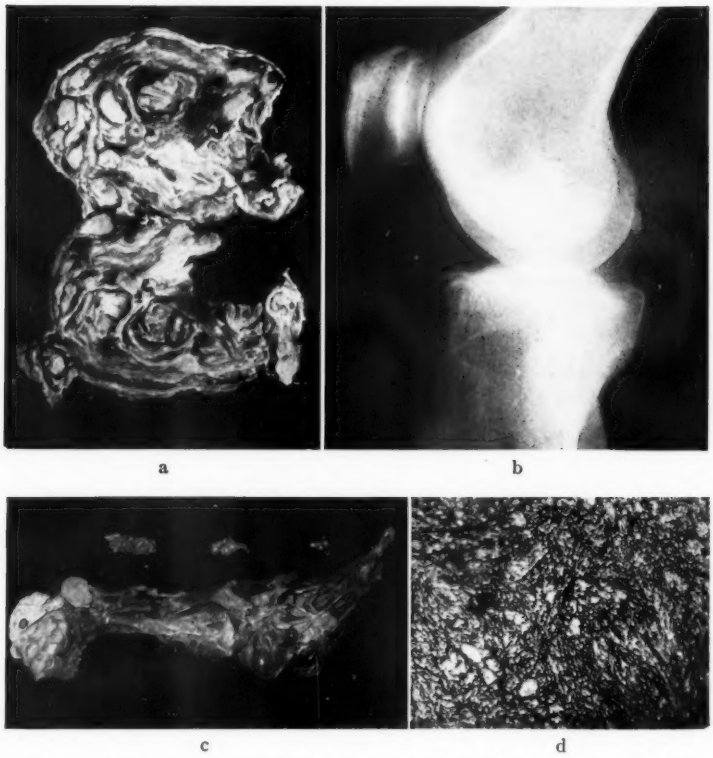


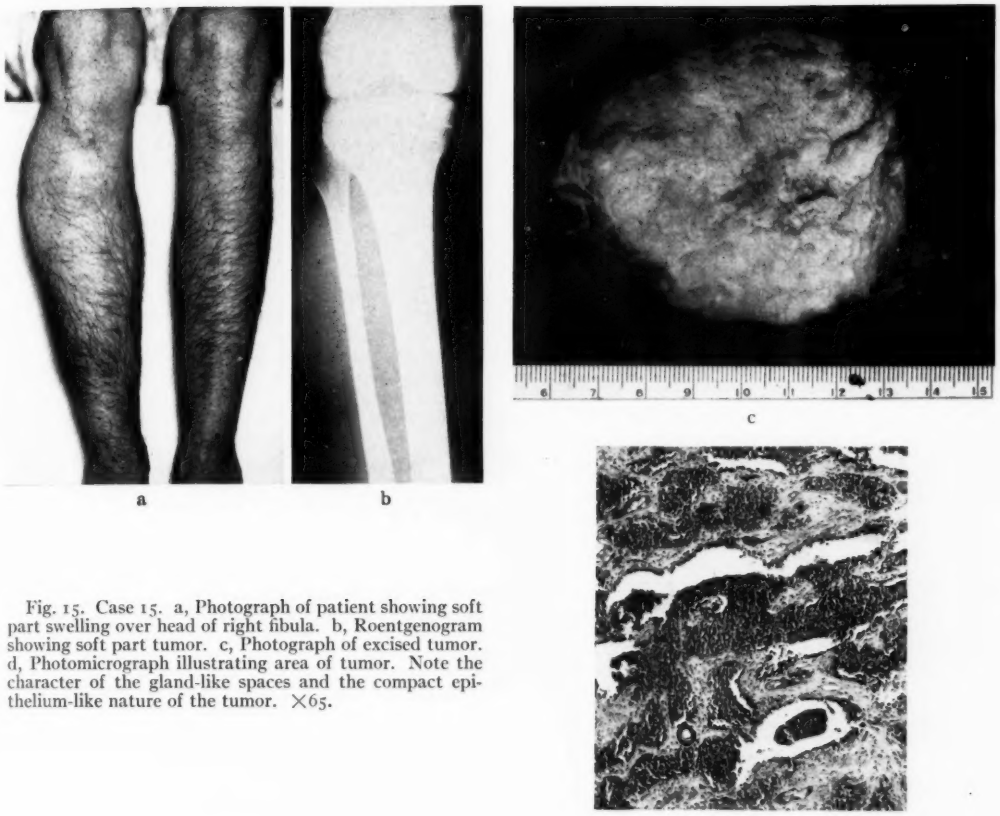
Fig. 14. Case 14. a, Photograph of drawing of bisected specimen, $^{5}/_{7}$ actual size. Note the cystic center, the nodular cut surface and the dark pigmentation. b, Roentgenogram of original tumor in popliteal space. c, Drawing of specimen, ½ actual size, showing recurrent tumor of suprapatellar pouch and articular synovium. d, Photomicrograph, reticulum stain, confirming histiocytic character of tumor. Hemotoxylin and eosin sections identical with that in Figure 13c. ×75.

The general feature of the disease, the polymorphous aspect of the cells, is typically histiocytic. Because of the second recurrence with extensive invasion of the thigh muscles, Berger's Case 5 was treated by disarticulation of the hip.

Case 13 is identical with Case 14. Both of these tumors showed prompt local recurrence, the recurrence in Case 14 being intra-articular and invasive. Neither the recurrence of Cases 13 nor 14 showed xanthoma cells, although they showed classical histiocytic features otherwise similar to xanthomatous giant cell tumor. It is our belief at the present time that these tumors constitute a less malignant variety of synovial sarcoma more likely to prove locally malignant. On the other hand the tumor showed many features of Case 10 which proved malignant and capable of metastasis. The course of these 2 cases together with Berger's Case 5 will undoubtedly further establish the degree of malignancy of this type.

Case 14. Synovioma of right popliteal space, recurring after 11 months within the knee joint. Treated by local excision, synovectomy and amputation.

C. G., a male aged 46 years, was first seen in the clinic of the Hospital for Ruptured and Crippled on December 6, 1937, complaining of swelling and pain in the right knee beginning 1 month previously, without any apparent cause. He had visited a physician concerning it, had been given some oral



a b c d

Fig. 15. Case 15. a, Photograph of patient showing soft part swelling over head of right fibula. b, Roentgenogram showing soft part tumor. c, Photograph of excised tumor. d, Photomicrograph illustrating area of tumor. Note the character of the gland-like spaces and the compact epithelium-like nature of the tumor. ×65.

medication, and swelling subsided after 2 weeks. His past history was negative regarding any important illnesses.

Examination revealed a slight fullness of the entire knee joint, slight ballottement of the patella, and a palpable mass about the size of a walnut in the middle of the popliteal space. This was tense and slightly fluctuant.

Roentgenograms showed fluid within the joint capsule and a well defined density in the popliteal region.

A diagnosis of cyst of popliteal space was made and excision was advised. Patient refused to have this done.

Patient was next seen May 26, 1938, and stated that he had been free from pain until 1 week previous to this visit at which time he had a sudden recurrence of pain and swelling of the right knee. This gradually increased until he was entirely disabled. He had a temperature of 99.2 degrees, diffuse swelling, and generalized tenderness about the knee and some local increase in heat. The previously noted mass was present in the popliteal space. An aspiration of the knee joint was done and 250 cubic centimeters of a turbid yellowish fluid was obtained. Sedimentation rate was 45 millimeters in 1 hour. The patient was again advised to enter the hospital for excision of the cyst.

On June 1, 1938, the patient consented to operation, and on June 3, 1938, a large firm tumor lying medial to the medial head of the gastrocnemius and originating probably in a semimembranous bursa or tendon was excised.

The specimen was an encapsulated tumor 6 by 4 by 2 centimeters. There was some fat adherent to the capsule. On sagittal section the color was a mottled white and orange and in the center was an area of cystic softening, 1 centimeter in diameter, which contained some jelly-like material.

The microscopic features were identical with those in Case 13.

Patient was seen at monthly intervals and occasionally complained of vague aches about the knee. Nine months after operation a mass was noted over

the anterolateral aspect of the right knee in the suprapatellar pouch. There was no evidence of recurrence in the popliteal space.

He was readmitted on May 4, 1939.

Examination at this time revealed a healed scar in the popliteal region. Just above and lateral to the patella, there was a mass 4 centimeters in diameter, which was firm, freely movable, and in the suprapatellar pouch, not tender. There was demonstrable free fluid in the joint.

A diagnosis of recurrent synovioma was made, and the patient was operated upon on May 5, 1939, through a large anterior incision. The suprapatellar pouch was found to be filled with a firm pedunculated tumor mass extending back between the condyles of the femur. A total synovectomy was performed and followed by amputation 1 week later.

The specimen consisted of the resected synovial membrane of the knee joint with some adherent fatty tissue. When laid out, it measured 6 by 2 inches and averaged about ¼ of an inch in thickness. Grossly, it contained three chocolate brown firm, nodular pedunculated tags of adherent tumor tissue. These had a firm almost cartilaginous consistence. In addition, there was one large area which was irregular and nodular, which was also chocolate brown in color and corresponded to the mass which occupied the suprapatellar pouch. The gross appearance of the specimen was not unlike that of diffuse xanthomatosis of the knee joint.

Several microscopic sections of the small fragments were prepared. In general, the recurrence was basically the same as the original tumor.

Patient is alive without evidence of disease, May, 1940, 1 year after operation.

CASE 15. Synovioma probably originating in bursa or tendon sheath of right biceps femoris, treated by local excision followed by deep x-ray therapy. Death within 18 months of extensive pulmonary metastases.

E. B., an American male, aged 40 years, was first seen in the New Haven Hospital in April, 1934, when a meningioma of the right precentral region was removed. He recovered completely from this operation and in April, 1936, returned to the hospital. Almost since the brain operation 2 years before the patient had noticed that his right leg was slightly larger than the left. He had noticed in the last 6 weeks that the right leg had definitely increased in size. There was no history of trauma.

On physical examination there was found over the lateral surface of the proximal half of the right lower leg a firm, slightly tender, nonreddened oval mass, about the size of an orange. The laboratory findings were negative. A diagnosis of sarcoma of the right leg was made, the patient was operated upon, and the mass excised. The perineal nerve was found to course through the mass. The patient made an uneventful recovery, left the hospital approximately a month after operation. Following the operation he was given a course of deep x-ray therapy through three ports, medial, lateral, and posterior, through the region of the tumor and also to the right inguinal region. A chest plate at the time of the removal of the tumor failed to reveal any evidence of metastatic tumor. The patient re-entered the hospital in August, 1937, because of complaint of a cough and chest pain of about 2 weeks' duration. X-ray films revealed the presence of tumor metastases in the mediastinum and accumulation of fluid in both pleural cavities. The pleural fluid contained tumor cells. He expired with extensive metastatic tumor on October 24, 1937.

The specimen was an oval mass of tissue which measures 10 by 7 by 3.5 centimeters. Its external surface was roughened and showed a few short tags of muscle and fibrous tissue adherent. The tumor was moderately soft, cut readily, and revealed a pink-gray cut surface; the tissue was succulent and friable and in the central portion had a yellow opaque appearance where it had become necrotic. There was a suggestion of a thin fibrous tissue capsule about the tumor which appeared to be invaded by tumor in several places.

Microscopic sections from various portions all showed an essentially similar appearance. The tumor was cellular and was composed of cells of fairly uniform size and shape. They were somewhat polyhedral in outline, with a finely granular pink staining cytoplasm with round or oval basophilic, hyperchromatic nuclei. There were one or two mitoses per high power field. In some fields the cells surrounded connective tissue stalks which gave the tumor a papillary architecture. In other places long slit-like spaces lined by flattened tumor cells were seen. These were surrounded by masses of the polyhedral cells. A thin fibrous tissue capsule which was invaded by tumor was present. The tumor also invaded the surrounding skeletal muscle and was also present as tumor thrombi in some of the surrounding blood vessels.

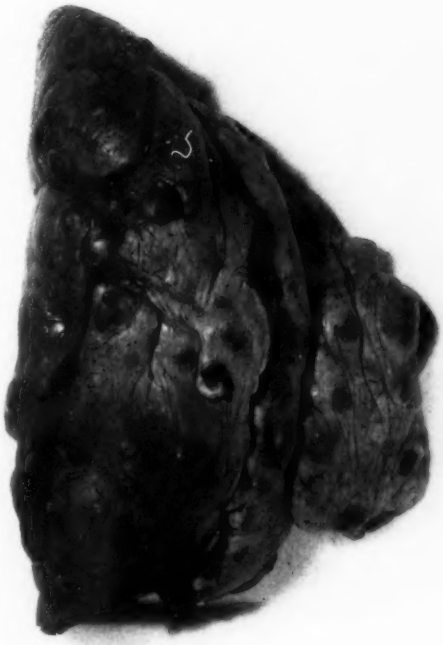
The dominant histological feature was the reproduction of neoplastic villi similar to that in areas of Case 1. Other areas suggested reticulum cell sarcoma.

The following case is of interest because it represents one of the few, if not the only, autopsy record of a synovial sarcoma.

CASE 16. Synovioma of right antecubital fossa and overlying right lateral epicondyle, treated by local excision followed by deep x-ray therapy. Death within 7 months of generalized metastases. Autopsy.

S. M., an Italian male, aged 45 years, was admitted to the New Britain Hospital on May 10, 1938.

On first admission in December 6, 1937, he had complained of a swelling on the right lateral aspect of the right arm just above the lateral condyle extending medially into the antecubital fossa. He stated that about 40 days previous to this admission he felt a small nodule about the size of the tip of the



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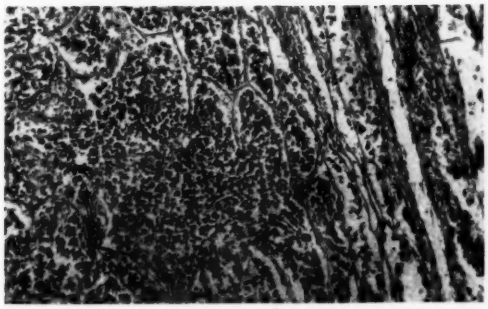

b

c

Fig. 16. Case 16. a, Nodular pulmonary metastases seen at autopsy. b, Photomicrograph of pulmonary metastases, reticulosarcomatous character. ×100. c, Metastases in right ventricular endocardium, about ⅗ actual size.

thumb. The nodule grew in size, without associated pain, heat, or redness, and without impairment of motion.

On the right lateral aspect of the right arm about 1 inch above the lateral epicondyle and extending medially toward the antecubital fossa, was a nodular mass about the size of an English walnut. It was not very hard and appeared to be fixed to the deep tissue, but not to the skin.

Biopsy was performed on December 6, 1937. The pathological diagnosis was malignant synovioma, and the patient was discharged on December 10, 1937. Deep x-ray therapy was begun on December 27, 1937.

Examination of microscopic sections revealed a highly cellular tumor composed of a syncytial arrangement of pale endothelium-like cells with large oval reniform or rounded nuclei. The arrangement of the tumor was largely perithelial. In areas, however, compact epithelium-like cell masses were present.

His second admission was on March 13, 1938, at which time he complained of pain in the back, especially on walking, for the previous 2 or 3 weeks. The pain was also present posteriorly at both iliac crests. At this time there was some tenderness to pressure over the posterior half of both iliac crests. There was marked point tenderness over the spine at the level of the eleventh and twelfth dorsal vertebrae.

On March 14, x-ray examination of the spine and chest showed two definitely rounded areas in the right lung field; one about the size of a quarter, the other about the size of a silver dollar, both lying in the lower lung field. The left lung showed one soft rounded shadow in the lower portion. There was also destruction of the spinous process of the twelfth thoracic vertebra. Following discharge the patient was admitted to the Memorial Hospital, where further irradiation was given.

His third admission was on May 10, 1938. He complained of excruciating pain in the right lower chest and some pain in the left chest, right sacrum, and lower posterior back. There was also pain in both legs. At this time there was some tenderness of the right upper abdomen and the liver appeared to be enlarged. Palpation of the lower back revealed marked tenderness over the right sacrum and isch-

TABLE I.—ANALYSIS OF 16 CASES OF SYNOVIAL SARCOMA

Sex	Age at onset	Location	Pre-operative symptoms				X-ray findings	Pre-operative diagnosis	Treatment and course	Post-operative follow-up	Microscopic features
			Pain	Fluid swelling	Tumor	Dysfunction					
E. P. ♂	29	Right elbow Para-articular	¤	¤	6 mos. duration	6 mos. restriction of motion	May, 1939. Circumscribed tumor showing calcification	Fibrosarcoma	May, 1939. Local excision. Deep x-ray therapy. Alive, with metastasis ? in axilla, July, 1940	14 mos.	Epithelial sarcoma "Adenosarcoma." Reticulosarcoma. Papillary neoplastic villi.
J. B. ♂	63	Left elbow Para-articular	¤	¤	2 yrs	o	Not done	Tumor	August, 1939. Local excision. Alive, no evidence of disease, July, 1940	11 mos.	Classical "adeno-sarcoma."
C.V. ♀	40	Left elbow Olecranon bursa	¤	o	10 yrs.	¤	Not done	Chronic bursitis	November, 1939. Local excision. Recurrence May, 1940. Second excision	6 mos.	Reticulosarcoma. Spindle-cell sarcoma. "Adenosarcoma."
C. C. ♀	26	Right thigh near lesser trochanter	3 mos.	o	9 mos.	¤	January, 1940. Soft part tumor, no bone involvement	Soft tissue sarcoma	Patient refused amputation. February 17, 1940. Excision of encapsulated cystic mass 8 by 15 cm. Deep x-ray therapy. Large recurrence, May, 1940	2 mos.	"Adeno-sarcoma." Reticulo sarcoma. Xanthosarcoma.
H. S. ♂	22	Left knee Articular, supra-patellar pouch. Popliteal space	6 yrs. 1 mo.	o	o	6 yrs. 1 mo.	June, 1932. Increased soft tissue below patella May, 1937. Pulmonary metastases	1932. Synovitis 1933. Deranged cartilage 1937. Synovioma	1932. Physiotherapy and strapping 1933. Excision of semilunar cartilage February, 1937. Midthigh amputation May, 1937. Pulmonary metastasis. Died March, 1938	13 mos.	Spindle-cell sarcoma. Reticulosarcoma. "Adenosarcoma."
G. B. ♂	19	Left knee Para-articular	2 yrs.	¤	2 yrs.	¤	September, 1938. Calcified soft part tumor	Tumor	September, 1936. Local excision, recurrence in 9 months September, 1938. Second excision. No evidence of disease, December, 1939	1 yr.	Fibrosarcoma with calcification. Reticulosarcoma.
E. S. ♀	35	Right knee Articular and popliteal space	2½ yrs.	o	¤	2½ yrs. contracture	January, 1935. Negative December, 1936. Atrophy, narrow joint space	1935. Ruptured semilunar cartilage	January, 1935. Excision of external semilunar 1930. Stretching for flexion contracture February, 1937, midthigh amputation December, 1939. Pulmonary metastases	2½ yrs.	Spindle-cell sarcoma. "Adeno-sarcoma."
L. M. ♂	18	Left knee Popliteal space	6 yrs.	o	1 yr.	6 yrs.	November, 1935. Calcified popliteal tumor October, 1936. Recurrent calcified tumor February, 1937. Pulmonary metastases	November, 1935. Calcified bursa October, 1936. Synovioma	November, 1935. Local excision, local recurrence October, 1936. Local excision followed by deep x-ray February, 1937. Midthigh amputation September, 1935. Died of pulmonary metastases	3 yrs. 10 mos.	Fibrosarcoma with calcification.
A. S. ♀	28	Left wrist Para-articular	o	¤	6 yrs.	¤	March, 1939. Calcified soft part tumor	Synovioma	March, 1939. Local excision. Alive, no recurrence, December, 1939	9 mos.	Fibrosarcoma with calcification. Adenosarcoma.

TABLE I.—ANALYSIS OF 16 CASES OF SYNOVIAL SARCOMA—Continued

TABLE I.—ANALYSIS OF 16 CASES OF SYNOVIAL SARCOMA—Continued

Sex	Age at onset	Location	Pre-operative symptoms				X-ray findings	Pre-operative diagnosis	Treatment and course	Post-operative follow-up	Microscopic features
			Pain	Fluid swelling	Tumor	Dysfunction					
H. N. ♂	25	Right knee Articular	10 yrs.	■	o	10 yrs.	1924. Articular soft tissue tumor	1913 to 1924. Synovitis	1913 to 1924. Conservative treatment February, 1924. Resection, followed by local recurrence February, 1925. Deep x-ray, Coley's toxins February, 1926. Resection followed by amputation. Died 1936, pulmonary metastases	10 yrs.	Fibrosarcoma with chondrification. Fibroendothelioma.
R. L. ♂	19	Left knee Articular, and suprapatellar pouch	6 yrs.	†	o	6 yrs.	April, 1935. Suprapatellar tumor, unnoticed July, 1937. Recurrent tumor	April, 1935. Synovitis March, 1936. Tumor of quadriceps	March, 1936. Local excision. Local and articular recurrence in 14 mos. October, 1937. Excision and deep x-ray 1890R, 3 portals February, 1938. Midthigh amputation December, 1938. Died, generalized metastases	2 yrs. 9 mos.	Fibrosarcoma with spaces and clefts. Calcification. Reticulosarcoma.
E. S. ♀	30	Right fourth finger Flexor tendon	†	o	o	6 mos.	Not done	October, 1937. Dupuytren's contracture	February, 1938. Local excision followed by 24 x-ray treatments May, 1939. Recurrence; midforearm amputation. Alive, without evidence of disease, December, 1939	1 yr. 10 mos.	First epitheliosarcoma recurrence, atypical synovioma.
H. B. ♂	48	Left knee Popliteal space	o	o	1 mo.	1 mo.	July, 1937. Soft part popliteal tumor March, 1939. Negative chest plate	"Tumor"	July, 1937. Local excision November, 1937. Recurrence and second excision. Alive, without evidence of disease, July, 1940	3 yrs.	Chondromatous giant cell tumor features. Reticulosarcoma, synovial spaces
C. G. ♂	46	Right knee Articular and semimembranosus bursa and tendon	2 yrs.	2 yrs.	o	2 yrs.	December, 1937. Fluid, swelling in knee joint	"Popliteal cyst"	May, 1936. Aspiration of joint June, 1938. Excision March, 1939. Synovectomy for intra-articular recurrence followed by amputation. Alive, without evidence of disease, December, 1940	1 yr. 6 mos.	Chondromatous giant cell tumor features. Synovial spaces.
E. B. ♂	40	Right knee Bursa of biceps femoris	o	o	2 yrs.	o	April, 1936. Soft part tumor October, 1937. Pulmonary metastases	Fibrosarcoma	April, 1936. Excision and deep x-ray to right groin October, 1937. Pulmonary metastases and death	18 mos.	Papillary neoplastic villi. Reticulosarcoma.
S. M. ♂	45	Right elbow Para-articular	o	o	1 mo.	o	March, 1938. Pulmonary and spinous metastases	"Tumor"	December, 1937. Local excision and deep x-ray March, 1938. Deep x-ray to skull and spine for pulmonary, cranial, and vertebral metastases. Died May, 1938	5 mos.	Reticulosarcoma.

ium. There was an area of tanning of the lower back where the patient had received x-ray therapy. His temperature fluctuated between 99 and 102 degrees. During the last week, it was constantly elevated and ranged between 101 and 105 degrees. On this admission, there was a bald area on the right side of the scalp, where there had previously been a tumor. There was also a tender mass about the size of a large walnut over the left parietal region. Deep x-ray therapy was continued, but the patient's condition became worse. On May 23d, while going to the bathroom, he placed his arm on the door and sustained a pathological fracture.

He continually complained bitterly of pain in the right sacrum and right leg. Antisnake venom was administered in three doses with marked relief of the pain. He continued to fail, however, and on June 13 became comatose. He expired on June 14, 1938.

Clinical diagnosis: Malignant synovioma of the right elbow with multiple metastases to lung and bones.

Autopsy examination was permitted. Subject was an emaciated adult, white male, weighing 100 pounds; body length, 164 centimeters.

Two soft rounded fluctuant tumor nodules were located in the right and left parietal regions. In the right upper extremity, about 3 centimeters above the lateral condyle, there was a firm, rounded mass not attached to the skin. Medially, and anteriorly above the antecubital space was a smaller, similar nodule about 1 centimeter in diameter. The large nodule was located near the upper end of a healed linear scar, which represented the site of the previous operative incision. There was a fracture of the upper third of the left humerus.

When the abdominal cavity was opened, a small, firm hemorrhagic red nodule 1½ centimeters in diameter was found in the greater omentum, and several similar, but smaller, nodules were found on the lesser omentum near the attachment to the stomach.

One nodule was found in the right ventricle and one in the left ventricle of the heart.

Both lungs were large, heavy, and studded with innumerable nodular metastases.

The pancreas showed an area of tumor tissue invading the tail of the organ.

There were no metastases to the liver, adrenals, spleen, kidneys, or gastro-intestinal tract.

Nodular metastases occupied the fifth, sixth, seventh, and twelfth ribs.

Summary of the findings, therefore, indicates local recurrence of the tumor with widespread metastases to the lungs, heart, pancreas, ribs, dorsal vertebra, omentum, scalp, and left humerus.

In the metastases of the tumor as seen in the lung, the tumor was composed of small, rounded nuclear elements about the size of a lymphocyte, supported by a fine delicate reticulum. Here the aspect was typical of certain forms of reticulosarcoma.

SUMMARY

A study of the 16 personally observed cases of synovial sarcoma comprises the largest single series to be reported in the literature and enables one to draw certain conclusions of the clinical course and histological behavior of this condition.

Histologically, all the varieties of synovial sarcoma, however extreme and variable they may appear to be, exhibit *specific* characteristics which permit of their identification. Nor is the time far distant when the malignancy and radiosensitivity of this tumor will be graded as accurately as is now possible for other malignant tumors.

The evolution of all synovial sarcomas may be correlated with various functional and histological characteristics of normal synovial tissue. The characteristics previously mentioned are here reiterated:

1. An endothelial structure and function. The lining synovial cell represents a differentiated form of synovial histiocyte destined to play a border or endothelial function. In the synovial sarcomas, the endothelial function is frequently exhibited as glandlike spaces resembling "adenosarcoma," as sheets or nests of epithelium-like cells, as neoplastic villi, or as well differentiated synovial borders. In order of malignancy these tumors appear to lie midway between the classical histiocytic tumors and the reticulosarcomas (Grades 2–3).

2. A histiocytic structure and function. Normal synovial tissue develops as a histiocytic tissue in the embryo where numerous argyrophilic threads are present. In adult life this histiocytic property persists, and is exemplified by lipophagic, siderophagic, and anthraphagic potentialities. The histiocyte is a relatively totipotent mesenchymal element and is capable of wide ranges of differentiation and dedifferentiation. Microscopically, the histiocytic tumors exhibit themselves in several forms. A classical polymorphous histiocytic aspect with giant cells, intracellular inclusions of blood pigment as tumors with classical giant cell features, not greatly different from xanthomatous giant cell tumor. Islands of xanthoma cells may be occasionally present. The behavior of this variety of syn-

ovial sarcoma suggests malignancy of a low order (Grades 1–2).

3. Synovial sarcoma may appear as a de-differentiated fibroblastic tumor generally indistinguishable from fibrosarcoma or spindle cell sarcoma unless synovial clefts or small areas of reticulo-endothelial evolution are located. Identification requires multiple sections and careful differential staining. The malignancy of this type would appear to follow closely that of fibrosarcoma and spindle cell sarcoma. In general, slow growth and late metastases is the rule. Moreover, calcification, chondrification, and ossification probably succeed a type of albuminoid impregnation of the tumor and when present in a tumor whose location suggests a synovial origin, should lead to further attempts to establish the specificity of the tumor.

4. Mucin formation is not infrequently exhibited in synovial sarcomas and appears to be confined to the endothelial cell components.

5. Clinically, synovial sarcomas in knee joints extend over a long insidious pre-operative course covering an average period of 5.6 years. The surgeon therefore has a reasonably long period in which to institute radical therapeutic procedures and must be ever on the alert for atypical forms of so called synovitis.

6. Synovial sarcomas in other para-articular regions manifest themselves more readily as soft part tumors usually after an average period of a few to several months. The poor end-results are undoubtedly caused in part by the procrastination of the patient and of the surgeon.

7. Amputation is the treatment of choice for all synovial sarcomas. It may be justifiable in instances when the tumor is small and encapsulated, to perform wide local excision and defer amputation until pathological examination has permitted time for histological study. Amputation should never be deferred beyond the time of the first recurrence.

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BACTERIAL FLORA OF ACUTE TRAUMATIC WOUNDS

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TRAUMATIC wounds present conditions in regard to the possibility of infection which are quite different from those ordinarily encountered in aseptic surgery. Bacteria, both aerobic and anaerobic, are carried into the tissues from the surrounding skin as well as on clothing and other foreign bodies introduced by the agents producing the trauma. Tissues are destroyed to a variable degree, and such devitalized tissues furnish an excellent medium for bacterial growth. Certain of the contaminating bacteria may produce a violent spreading infection including the dreaded gas gangrene. Bacterial cultures, therefore, become a necessary basis for the intelligent treatment of accidental wounds. This study concerns itself with the analysis of the bacterial flora cultivated from 200 acute traumatic, previously untreated wounds.

The older studies on the bacteriology of accidental wounds were in many instances inadequate because of lack of satisfactory anaerobic and aerobic methods of cultivation. The means of obtaining the cultures were not always such as to bring to light every type of organism present. Often cultures were secured from only one part of the wound and without the benefit of anaerobic bacteriological studies.

Riggenbach (1898) was probably the first to suggest the importance of anaerobes as well as aerobes in accidental wounds. His method was to swab the surface of the wound with cotton which was inoculated into broth, one-half being incubated aerobically and one-half anaerobically. From 24 cases he isolated Staphylococcus albus, 14 times; Staphylococcus aureus, 4 times; streptococci (kind not mentioned), 6 times; Micrococcus tetragenus, 5 times; pneumococci, twice; Friedlaender's bacillus and Bacillus coli, once each. Clostridium tetani was seen twice. No mention is made of other anaerobes. He found that all the wounds showed a mixed flora, either with saprophytes which were easily identified or, sometimes, with unknown rods and cocci. He concluded that wounds may contain pathogenic bacteria without clinical evidence of infection, these disappearing as healing progresses.

There is an enormous literature on the bacterial flora of war wounds of the First World War (3). These studies are important in that they directed attention to the frequency with which gas gangrene producing anaerobes could be cultivated from wounds, especially the deep puncture wounds and muscle traumatisms in which soil, clothing, shrapnel, etc. were implanted in the depths of the wound. The bacterial flora present varied according to the type of injury, the technique for cultivating the organisms, the manner in which the cultural material was obtained, the time interval from injury to the making of the culture, et cetera. Another important contribution from these studies was the observation that a combination of gas gangrene organisms with hemolytic streptococci produced a more virulent gangrenous infection than the anaerobes alone. Zeissler (1928) reported 21 cases of traumatic injuries in which anaerobes were isolated in each case. In 3, anaerobes were present without clinical evidence of anaerobic infection; in 8 cases there were anaerobes found with clinical evidence of infection and recovery. In the 10 remaining cases the anaerobic infections were fatal. Anaerobes alone were isolated from 13 of the wounds. Aerobes and anaerobes were combined in the 8 others. The anaerobes grown were Clostridium welchii, 21 cases; Clostridium oedematiens, 7 cases; Vibrion septique, 1 case; Clostridium histolyticum, 1 case; Clostridium tetani, 3 cases. Of the nonpathogens there were: Clostridium tertium, 4 cases; Clostridium sporogenes, 3

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cases; and Clostridium bifermentans, 1 case.

Sas (1930) studied 55 accidental wounds, a few minutes to 20 hours after injury—in most cases one-half hour's duration—by introducing two sterile silk knots into the wound "until they were saturated with the wound secretions," then culturing the knots aerobically and anaerobically. The pyrogallic acid-alkali method for culturing anaerobes was used. He isolated Staphylococcus albus, 23 times, 41.8 per cent; streptococci (kind not mentioned), 19 times, 34.5 per cent; Staphylococcus aureus, 11 times, 20 per cent; Bacillus coli group, 5 times, 9 per cent; Staphylococcus citreus, twice, 3.6 per cent; pneumococci, twice, 3.6 per cent; gas producing anaerobes, 11 times, 20 per cent. Eight of the anaerobes were identified as Clostridium welchii. Not all of the bacteria could be identified. Among the saprophytes were found 16 bacilli, 23 cocci, 7 sarcinae, 1 streptothrix. He concluded that accidental wounds are always contaminated and are more serious than clean operative wounds, especially because gas gangrene producing bacilli may be present without any manifest infection.

Veraart and Dreuth (1930) cultured swabs from secretions of 215 fresh, previously untreated wounds with the following results: 41 per cent of the cases were sterile; 15.5 per cent yielded 100 or more colonies of bacteria. After intensive cleaning with hydrogen peroxide, dilute spirits and ether, then 5 per cent tincture of iodine, 86.5 per cent were sterile and in the remainder there were no wounds which showed more than 100 colonies.

Dimtza and Gutscher (1933) studied 424 wounds by culturing all the excised tissue débrided. Ninety-two cases were found bacteria-free. The 332 others showed staphylococci alone in 108 cases, and mixed with streptococci and colon bacilli in 59 cases; streptococci alone in 31 cases, and mixed with staphylococci and colon bacilli in 62; colon bacilli alone in 10 cases, and mixed with staphylococci and streptococci in 21; Clostridium welchii in 57 cases. They believe that the high incidence of Clostridium welchii, 20 per cent, indicates that gas gangrene must always be reckoned with, especially in railroad and street accidents, all cases of which showed contamination with these organisms. However, gas gangrene did not develop in all these cases, clinical symptoms having occurred in only 8. The Clostridium tetani was isolated twice, both times from street accident cases, but tetanus did not develop in either.

Sviridov (1936) studied both bacteriologically and clinically 120 acute traumatic wounds before and after épluchage and débridement, by direct smear of the wound surface at the level of the skin, the muscle and bone, and by cultures from the same levels. Anaerobic cultures were not made because of lack of equipment. There were 45 skin wounds, 38 skin and muscle, and 37 skin, muscle, and bone injuries. One hundred cases were treated by épluchage and 20 by débridement. In 100 cases before épluchage he found streptococci (kind not noted) in 13 cases; staphylococci in 25 cases; diplococci in 5 cases; staphylococci with streptococci in 8 cases; streptococci with diplococci in 6 cases; streptococci, diplococci, and staphylococci in 1 case; Bacillus coli in 7 cases; Bacillus subtilis in 14 cases; other cocci in 21 cases; yeast cells in 2 cases; other saprophytes in 71 cases. After épluchage 27 cases showed pathogenic flora, 28 saprophytes only, and in 45 cases no growth was obtained. Eighty-three of the cases healed by primary intention and 17 suppurated. In the latter staphylococci were grown 5 times; streptococci, 3 times; streptococci with staphylococci, 2 times; and Bacillus coli in 1 case. After épluchage 15 per cent of the cases which healed by primary intention gave growth on culture, yet infection did not take place. All these were face and skull wounds. Wounds in this area possess greater resistance to infection and heal by primary intention in 86 per cent of the cases. Wounds of the thigh, shoulder, and pelvis with muscle and bony involvement give the most unsatisfactory results, due to the frequent inability to remove completely all the contaminated tissue. In 20 débrided wounds 1 case of gas gangrene and 1 case of osteomyelitis developed. Both recovered.

Levaditi (1939), during the present World War, cultured wound secretions on cotton swabs from 68 wounds, including 35 flesh wounds, 22 compound fractures, 7 accidental wounds, and 4 amputations; 75 per cent of

TABLE I.—BACTERIAL FLORA OF 102 "CLEAN" AND 98 "DIRTY" WOUNDS ACCORDING TO DURATION OF INJURY

Time from injury to culture	5′		10′		15′		20′		30′		45′		60′		60′ plus		C.	D.
	C.	D.	C.	D.	C.	D.	C.	D.	C.	D.	C.	D.	C.	D.	C.	D.		
No. of cases	23	13	28	21	17	21	7	8	15	18	5	5	2	5	5	7	Total	Total
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Staphylococcus albus	56.5	92.3	78.6	85.7	100	80.9	85.7	87.5	66.7	88.8	100	100	100	100	60	85.7	77(75.4)	85(86.7)
Staphylococcus aureus	56.5	46.1	50	52.4	29.4	52.4	57.1	50	80	33.3	80	40	50	60	60	71.4	56(54.9)	48(49)
Streptococcus hemolyticus, aerobic	17.4	38.4	7.1	19	—	4.8	—	12.5	—	11.1	—	—	50	40	—	42.8	7 (6.8)	18(18.3)
Streptococcus hemolyticus, microaerophilic	—	—	3.6	9.5	—	4.8	—	25	—	11.1	20	—	—	—	—	—	2 (1.9)	7 (7.1)
Streptococcus, nonhemolyticus, aerobic	34.7	23	21.3	9.5	35.3	14.2	28.5	12.5	20	11.1	40	—	50	—	20	—	29(28.4)	11(11.2)
Streptococcus, nonhemolyticus, anaerobic	4.3	—	7.1	9.5	11.7	—	—	—	6.7	11.1	—	40	—	—	—	14.2	6 (5.8)	7 (7.1)
Streptococcus viridans	13	7.7	10.7	—	—	23.8	—	12.5	6.7	11.1	—	—	—	—	40	28.2	7 (6.8)	11(11.2)
Clostridia	8.7	15.4	7.1	9.5	17.6	28.5	14.2	25	20	44.4	—	60	50	100	—	71.4	12(11.1)	34(34.6)
Enterobacteria	17.4	15.4	25	14.2	29.4	38.9	28.5	25	6.7	16.7	20	60	50	20	—	42.8	21(20.5)	25(25.5)
Anaerobic gram negative bacilli	—	—	3.6	4.7	—	—	14.2	—	—	—	—	—	—	—	—	—	2 (1.9)	1 (1)
Gram positive aerobic spore-bearing	47.8	38.4	35.7	35.2	41.2	47.6	28.5	25	13.3	55.5	20	40	50	40	—	85.7	34(33.3)	46(46.9)
Micrococci	8.7	15.4	28.5	23.8	41.2	4.8	28.5	12.5	33.3	5.6	60	20	50	60	40	28.4	30(29.4)	19(19.3)
Diphtheroids	4.3	—	3.6	4.7	5.9	9.6	14.2	—	—	5.6	—	—	—	—	—	—	4 (3.9)	3 (3)
Gram negative cocci	—	—	3.6	—	—	—	—	—	—	—	—	—	50	40	—	—	2 (1.9)	2 (2)

the cases contained 3 bacterial species or less; 1 case was sterile, and the others contained 4, 5, or 6 species. The types of organisms isolated were staphylococci, 85 per cent; streptococci (kind not stated), 58 per cent; Escherichia coli, 41 per cent; enterococci, 28 per cent; Clostridium welchii, 17 per cent; Bacillus pyocyaneus, 7 per cent. Other types commonly isolated were sarcinae, Bacillus subtilis, and Bacillus proteus.

Rathcke (1940) studied excised tissue fragments from 140 wounds. Clostridium tetani, pathogenic for mice, were isolated from 6 wounds—1 street accident, 2 agricultural, 1 sport, 1 railroad, and 1 glass injury. Other organisms found were various clostridia (kind not mentioned), 21 times; staphylococci, 109 times; streptococci (kind not mentioned), 28 times; Bacillus coli, 7 times; aerobic spore bearing rods, 29 times; gram positive nonspore bearing rods, 16 times; diphtheroids, 16 times; enterococci, 8 times; actinomyces, once; other bacteria, 5 times. Two wounds yielded no growth. He recommends prophylactic antitetanus serum for all accidental injuries.

The results obtained by the different authors presented are difficult to compare because of the lack of uniformity of method of selecting material for examination. The studies of Veraart and Dreuth, and Dimtza and Gutscher, are surprising as regards the large number of cases from which sterile cultures were obtained. It might have enhanced the value of these investigations had the distinction been made between clinically clean and dirty wounds, likewise any relationship between the types of contaminating organisms and the age of the wound. In this study we have attempted to evaluate some of these factors.

MATERIAL AND TECHNIQUE

Fresh, accidental wounds, both in ambulatory and hospitalized cases, were studied. Cases of patients who had any form of treatment prior to arrival in the hospital were not included. The material for study was collected

TABLE II.—BACTERIAL FLORA OF 200 ACUTE TRAUMATIC WOUNDS

Time from injury to culture	5′	10′	15′	20′	30′	45′	60′	60′ plus	Total	%
No. of cases:	36	49	38	15	33	10	7	12	200	
Staphylococcus albus	69.4	81.6	89.4	80	78.7	100	100	83.3	162	81
Staphylococcus aureus	52.8	51	42.1	53.3	54.6	60	57.1	83.3	104	52
Streptococcus hemolyticus, aerobic	25	12.2	2.6	6.7	6.1	—	42.8	25	25	12.5
Streptococcus hemolyticus, microaerobic	—	6.1	2.6	13.3	6.1	10	—	—	9	4.5
Streptococcus nonhemolytic, aerobic	30.5	16.3	23.7	20	15.1	20	14.2	16.7	40	20
Streptococcus nonhemolytic, anaerobic	2.8	8.1	5.2	—	9.1	20	—	8.3	13	6.5
Streptococcus viridans	11.1	6.1	13.1	6.7	9.1	—	—	16.7	18	9
Clostridia	11.1	8.1	23.7	20	33.3	30	85.7	41.6	46	23
Enterobacteria	16.7	20.4	34.2	26.6	12.1	40	28.5	25	46	23
Anaerobic gram negative bacilli	—	4	—	6.7	—	—	—	—	3	1.5
Gram positive aerobic spore-bearing bacilli	44.4	36.8	44.7	26.6	36.3	30	42.8	50	80	40
Micrococci	11.1	26.5	21	20	18.1	40	57.1	33.3	49	24.5
Diphtheroids	2.8	2	6.3	6.7	3	—	—	—	7	3.5
Gram negative cocci	—	2	—	—	—	—	28.5	—	4	2

in the Accident Room and Surgery of the Frankford Hospital, Philadelphia, Pennsylvania, and the Emergency Ward of the Presbyterian Hospital, New York. The types of wounds included deep and trivial lacerated wounds, bullet, dog and human bite and other puncture wounds, machine and automobile accidents, traumatic amputations, and compound fractures. Most of the cases were lacerated wounds. Many were street accidents. The time period from injury to culture varied from a few minutes to 24 hours. The majority of cases comprised patients seen within one-half hour of the time of injury. It was difficult to obtain study material on cases longer than 1 hour's duration. Most of such patients had some form of antiseptic treatment applied en route to the hospital.

In collecting material we wished to cultivate not only the contaminating organisms deposited on the surface of the wound but also those lodged in the crevices and interstices. It was decided therefore to excise the traumatized tissue to the extent that it was representative of the wound as a whole, and to culture the excised tissue *in toto*. All our cultures, therefore, represent the bacterial flora present in tissue fragments débrided under general or local anesthesia, and prior to the institution of any treatment. As soon as the tissue was débrided it was introduced into tubes or flasks of liquid culture media. Rosenau's brain dextrose medium was first used. Later thioglycollate (1) media was substituted, its use obviating the necessity of preheating the media to drive off the contained air. We found the thioglycollate medium satisfactory for our purposes. The inoculated media was then taken to the laboratory accompanied by a slip stating the site, extent, and duration of the injury, with notation as to whether the wound appeared clean or dirty. We consider swab cultures inadequate.

The cultures were incubated overnight. If any failed to show turbidity, further incubation was done. The contents were mixed by means of a Pasteur pipette and a portion of the culture was removed and streaked on a pair of 5 per cent sheep's blood agar Petri plates. Another drop was placed on a glass slide for Gram stain. One plate was incubated aerobically and the other anaerobically in a McIntosh-Fildes type jar, evacuated to 350 millimeters mercury by means of a water pump, then slowly filled with hydrogen streaming over heat-activated palladiumized asbestos until a positive pressure was obtained. The aerobic plates were examined the next day, the anaerobic plates usually after 48 hours' duration. If there was no growth, the incubation of negative cultures was continued for 48 hours. When growth appeared on the plates, all the various colony types were fished and identi-

fied in the usual way, by morphological and cultural studies. Most cultures were replated, before discarding, for check on the original findings. Virulence tests on pathogens, groupings of the hemolytic streptococci, and coagulase tests on the staphylococci were not made. Molds and fungi were not identified.

RESULTS

Two hundred cases were studied, comprising 102 clinically "clean" cases, and 98 "dirty" or foreign body contaminated cases. The findings in the number of cases procured in each time period are presented in Tables I and II. The distribution of cases according to aerobic and anaerobic organisms cultivated is presented in Table III.

TABLE III.—AEROBIC AND ANAEROBIC ORGANISMS ISOLATED

	Clean		Dirty		Total	
	Cases	Per cent	Cases	Per cent	Cases	Per cent
Aerobes alone	80	78.4	53	54.2	133	66.5
Anaerobes alone	0		3		3	1.5
Aerobes plus anaerobes	22	21.6	42	42.8	64	32
	102		98		200	

The clinically "clean" cases predominate in the 5 and 10 minute groups, while in the older wounds there were more of the "dirty" cases. Six hundred and six different bacterial species were cultivated, making an average of 3 per wound. Aerobes alone were present in 133 cases or 66.5 per cent of the total. Anaerobes alone were cultivated from only 3 cases, 1.5 per cent, dirty wounds. Aerobes plus anaerobes were grown from 64 wound débridements, 32 per cent of total. All of the wounds studied yielded positive cultures. This is in contrast to the reports of Dimtza and Gutscher who found 92 wounds sterile, 21.7 per cent, in a total of 424, the technique for study being similar to this one, and to those of Veraart and Dreuth who reported 41 per cent of the cultures of 215 cases, sterile by the cotton swab method.

Anaerobes were present in 22 of the "clean" cases, 21.6 per cent of total, as against 42 of the dirty cases, 43.5 per cent of total. The presence of foreign bodies in dirty wounds, especially street dirt, undoubtedly contributes to the preponderance of anaerobes.

The percentage of anaerobes increased with the older wounds. Mason believes that organisms from human sources contaminating wounds usually gain entrance after, rather than at the time of, injury and that they may be introduced by the application of a soiled dressing or by handling the wound without proper aseptic precautions. It may be conjectured that these factors explain the increase in anaerobes noted in the older wounds.

Staphylococci. From the foregoing tables it is evident that these organisms can be isolated from nearly every wound. As is well known, however, staphylococci can be cultivated at will from the unbroken skin. The Staphylococcus albus was isolated 162 times, 81 per cent of cases, and the Staphylococcus aureus from 104 wounds, 52 per cent of cases. The distribution of both Staphylococcus aureus and Staphylococcus albus was about equal between the clean and dirty cases. Pigmentation is by itself of limited value in the differentiation of staphylococci. Division on the basis of hemolysis and production of human plasma coagulase has recently been shown to be advantageous, and in future studies this classification will be adopted. Staphylococci were found alone in only 7 instances. Associated with Staphylococcus aureus in 99 cases were Staphylococcus albus, 78 times; streptococci, 55 times (hemolytic, 17; green, 11; nonhemolytic, 27); gram positive aerobic spore-bearing bacilli, 33 times; clostridia, 23 times; enterobacteria, 11 times; micrococci and sarcinae, 29 times. Anaerobic organisms were isolated in conjunction with Staphylococcus aureus 33 times.

Streptococci. Next in frequency to the staphylococci, streptococci were recovered. From 101 wounds, 50 per cent, 105 isolations were made. The nonhemolytic variety accounted for 53 of this number, 40 being aerobic and 13 anaerobic. The hemolytic streptococcus was grown from 34 cases—aerobic, 25; microaerophilic, 9. Green streptococci were cultivated 18 times. The distribution is of interest. The clinically "clean" wounds showed the nonhemolytic streptococcus in 35 cases, 33.3 per cent (aerobic, 29; anaerobic, 6); and

the hemolytic species in 9 cases, 9 per cent. However, in the dirty cases, the hemolytic streptococcus was isolated 25 times—aerobic, 18; microaerophilic, 7, 25.4 per cent—while the nonhemolytic variety was found 18 times, 18.2 per cent. The green streptococci were found in the same proportion in clean and dirty cases. Pure cultures were rarely found. The organisms commonly isolated with the streptococcus are given in Table IV. It would have been of considerable interest to have grouped the hemolytic streptococci according to Lancefield's classification.

TABLE IV.—ORGANISMS COMMONLY ISOLATED WITH THE STREPTOCOCCUS

	Staphylococcus albus	Staphylococcus aureus	Hemolytic streptococcus R.	Hemolytic streptococcus N.	Nonhemolytic streptococcus R.	Nonhemolytic streptococcus N.	Green streptococcus	Clostridia	Enterobacteria	Bacillus subtilis group	Total cases
Nonhemolytic streptococcus R	32	20	1	0	–	0	1	7	7	8	40
Nonhemolytic streptococcus N	12	5	1	0	0	–	1	2	2	5	13
Hemolytic streptococcus R	19	14	–	0	1	1	1	12	2	13	25
Hemolytic streptococcus N	8	4	0	–	0	0	0	1	2	3	9
Green streptococcus	11	12	1	0	1	1	–	2	2	6	18

R—aerobic
N—anaerobic

Clostridia. This important group of organisms was isolated from 46 cases, 23 per cent of total. They contaminated the dirty wounds 3 times as frequently as the "clean" ones—34.6 per cent as against 11.1 per cent. Interestingly, the older the wound the more frequently were clostridia isolated from it. The same held true for the "clean" as well as the dirty wounds. The varieties isolated included: Clostridium welchii, 24 times; oedematiens (novyi), twice, bifermentans, once; multifermentans, 3 times; histolyticum, twice; aerofetidum, once; tetani, 3 times; tertium, 3 times; sporogenes, twice; botulinum, once; chauvei, once; not identified, 3. The organisms isolated with the clostridia were Staphylococcus albus, 39 times; Staphylococcus aureus, 22 times; streptococci, 24 times; gram positive aerobic spore-bearing bacilli, 17 times; enterobacteria, 8 times. No cases of gas gangrene and no cases of tetanus infection developed in the wounds from which these organisms were grown, treatment being instituted to prevent their activity. While the presence of these organisms in a wound does not guarantee infection, their high incidence is a forceful argument for keeping this possibility constantly in mind and for taking any possible steps to avoid it.

Enterobacilli. Forty-nine, or 24.5 per cent, of the wounds studied showed gram negative bacilli on cultivation, their presence being about equal in both the clean-looking and the dirty wounds. They were cultivated most commonly from hand and leg wounds, and least frequently from scalp wounds. The varieties isolated included: Escherichia, 13; Proteus, 13; Eberthella, 11; Shigella, 3; Alkaligenes, 2. Other gram negative bacteria isolated were: Bacillus pyocyaneus, 2; Friedlaender's bacillus, 1; Bacillus prodigiosus, 1.

The Proteus group was predominantly in the dirty wounds, 10 of the 13 isolations being in this group. The Eberthella group was predominant in the "clean" group, 7 of the 11 cases.

The organisms isolated in association with the gram negative bacilli were: Staphylococcus albus, 40 times; Staphylococcus aureus, 11 times; hemolytic streptococci, 4 times; nonhemolytic streptococci, 10 times; Bacillus subtilis group, 24 times; clostridia, 10 times; micrococci, 7 times; diphtheroids, 4 times.

Anaerobic gram negative bacteria are rare, 3 cultures only having been obtained. They were Bacterioides fragilis from a finger wound, Colibacterium moliniformis from a wrist wound, and Bacterioides tenuis from a scalp wound. Staphylococcus aureus infection developed in the wrist wound.

The saprophytic organisms isolated includep the gram positive aerobic spore-bearing bacilli, 77 times, 41.6 per cent of the cases; the micrococci, 46 times, 25 per cent of the cases; and the gram negative cocci, 3 times, 1.6 per cent. Molds were relatively infrequent, found in 9 wounds, 4.5 per cent of the cases.

SUMMARY

Accidental wounds are always found to be contaminated, no matter how early they are seen after injury. In 200 fresh, previously untreated traumatic wounds, cultures of débrided tissue showed bacteria present in every case. The types of wounds included lacerations, bullet, dog and human bite, and other puncture wounds; machine and automobile accidents; traumatic amputations and compound fractures. Contamination occurs usually with pathogenic and often with virulent organisms. Dirty wounds are apt to show hemolytic streptococci and the gas gangrene producing anaerobic bacilli more frequently than "clean" wounds. However, even clean-looking wounds may harbor these organisms with sufficient frequency to suspect their presence in every case. No one can tell which of these wounds is going to develop infection.

The important bacteriological findings in 200 cases are as follows: Staphylococcus aureus, 104 times, 52 per cent; hemolytic streptococcus, 34 times, 17 per cent; nonhemolytic streptococcus, 53 times, 26.5 per cent; green streptococcus, 18 times, 9 per cent; clostridia, 46 times, 23 per cent; enterobacteria, 46 times, 23 per cent; and the anaerobic gram negative bacilli, 3 times, 1.5 per cent. These organisms were rarely found in pure culture. (In many instances 2 or more pathogens were cultivated from the same wound.) Saprophytes, the gram positive aerobic spore-bearing bacilli and gram positive cocci, were frequently seen. An average of 3 different organisms was isolated from each wound. The older the untreated wound the more commonly were anaerobes cultivated.

The knowledge of the bacterial flora in any given contaminated wound gives a sound basis for the rational prophylactic treatment to be instituted to prevent infection in that wound.

NOTE: The characteristics of the staphylococci in 33 of the 200 cases were studied. Fifty-one different colonies were isolated in pure culture. Of these 39 were orange pigmented (aureus) and 12 were white (albus) variety. Thirty colonies were hemolytic on sheep's blood agar plates. All were pigmented (aureus). Nine of the pigmented strains were nonhemolytic.

Fresh undiluted oxalated human plasma and 4 hour dextrose broth cultures were employed in testing for coagulase. The development of a firm coagulum after 2 hours' incubation at 37 degrees C. was indicative of the presence of coagulase. Fourteen strains (8 cases) were coagulase positive. All these were hemolytic and pigmented. Sixteen hemolytic pigmented strains were coagulase negative and 21 nonhemolytic strains were also coagulase negative. The latter include the 12 nonpigmented albus strains.

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SULFATHIAZOLE AND SODIUM SULFATHIAZOLE IN THE TREATMENT OF POSTOPERATIVE PNEUMONIA

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IT is generally recognized that postoperative pulmonary complications are frequently encountered. The purpose of this communication is to present the results of therapy with sulfathiazole in a group of patients having postoperative pneumonia. Since "postoperative pneumonia" is a term that is often used quite loosely, it is first necessary to clarify its meaning. One of the most significant contributions made to this subject was that of Whipple in 1918. Using the term, "postoperative pneumonitis," he called attention to a little recognized but common form of postoperative pulmonary complication. This type occurred in the first 24 to 48 hours after operation, and its features were a rise in temperature, cough, increased respiratory rate, chest pain, and dullness over a portion of the lower lobes. Within a few days the symptoms subsided, the temperature declined by lysis, but the physical signs of consolidation persisted for a longer period of time. Pneumococci of the higher types were frequently isolated from the sputum of these patients. The mortality rate was low. In the light of subsequent studies by others, it is probable that the patients observed by Whipple had some degree of atelectasis associated with a low-grade pulmonary infection.

The careful clinical observations of King recorded more recently have given added information concerning the nature of postoperative pulmonary complications. He was particularly interested in those patients who, within 3 to 4 days after operation, developed fever, leucocytosis, cough, and purulent sputum. The types of pulmonary complications that these patients had could be divided into three main groups. The first were those with bronchopneumonia. The second group comprised patients having a massive collapse due to an occlusion of a bronchus by exudate. The largest number of cases fell into the third group, and included patients having a purulent bronchitis with a low-grade bronchopneumonia (pneumonitis), sometimes in association with atelectasis due to occlusion of bronchi by exudate. King emphasized that a purulent bronchitis was the basic lesion in this third group of cases. Irons and Apfelbach have lately called attention to the pathogenesis of so called aspiration pneumonia. While the term has been frequently employed by clinicians for many years, the precise nature of the condition has not been carefully studied. Irons and Apfelbach assert that a characteristic type of pneumonia results from the aspiration of stomach contents during operation or shortly thereafter. Its features are hemorrhage, hyperemia, edema, and advanced postmortem and retrogressive changes in the lungs. In acute cases, the bacterial flora of the stomach, lung, and bronchi are almost the same. The condition has been reproduced in dogs by the intratracheal introduction of stomach contents.

It is apparent that the pathogenesis of postoperative pneumonia is dependent upon several factors. Whipple has summarized some of the predisposing factors as follows: recent or concurrent inflammation of a part of the upper respiratory tract; pulmonary congestion; inhibition of normal respiratory movements or excursions as a result of abdominal incision; and debilitated states, such as sepsis and cachexia. Other important factors are the increased frequency of upper respiratory infections occurring during the winter and spring months, and a rise in the carrier rate of virulent pneumococci among the general population. The rôle of pulmonary congestion in the evolution of postoperative pneumonia must be stressed, because of its significance and because, in many instances, it can be prevented.

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Since pneumococci of the higher types are frequently found in the nasopharynx of normal individuals, under certain operative and postoperative conditions, these organisms may pass into the lower respiratory tract and cause an inflammatory reaction in the congested pulmonary tissue. Contributing factors are a diminution of the respiratory excursions and the cough reflex. Agencies responsible for pulmonary congestion in patients are the administration of excessive amounts of sodium chloride, and unreasonable quantities of fluids given intravenously, both associated with cardiac failure.

Our clinical experience at the University Hospital has been similar to that expressed by King. We have found it very difficult to differentiate pneumonitis from atelectasis. This problem can be approached only on the basis of physical and x-ray findings. Recognizing that a purulent bronchitis is the underlying lesion of both conditions, the physical findings of pneumonitis include dullness, increased tactile fremitus, increased bronchial breathing and whispered voice, and fine crackling râles. An x-ray film of the chest may or may not reveal an increased area of density. If a bronchus becomes occluded by exudate, the findings are those of atelectasis which are dullness, decreased tactile fremitus, and decreased breath sounds and whispered voice. X-ray findings of considerable aid reveal an elevation of the diaphragm of the affected side, an increased area of density, and in some instances, a shift of the mediastinum. However, confusion arises many times because atelectasis may occur and then the bronchial exudate is coughed up without a simultaneous expansion of the collapsed lung. In this event there is the free passage of air into an area of atelectasis, and the physical findings closely approximate those of pneumonitis. Even an x-ray film may not be helpful in the differentiation because the diaphragm may be elevated in both instances following an abdominal operation. Although King found that only about one-half of his cases of pneumonitis were accompanied by a demonstrable atelectasis, we have been unable to make a differentiation of our cases with the same degree of accuracy.

In summary then, postoperative pneumonia is not a specific clinical entity. It may include patients having a typical lobar or lobular type of consolidation due, in most instances, to the pneumococcus. The mortality rate in this group of cases is high. The most common form involves those patients having a purulent bronchitis, which results in a low-grade type of pulmonary inflammation known as pneumonitis, or in atelectasis. A number of patients may have both atelectasis and pneumonitis. Considerable difficulty attends the differentiation of these two types. Finally, there is a type described by Irons and Apfelbach called aspiration pneumonia.

We have endeavored to clarify the present status of the pathogenesis of postoperative pneumonia because of its direct bearing on the problem of therapy. It is not an easy task for the medical consultant to decide clinically whether he is being confronted with a patient who has a relatively benign lesion such as pneumonitis and/or atelectasis, or who has the early manifestations of a lobar or lobular type of pneumococcic consolidation. Furthermore, what may appear to be a benign process may progress to frank areas of consolidation and endanger the life of the patient. Therefore, for the protection of the patient everything in the form of treatment should be carried out, and specific therapy, if available, should be instituted without delay.

Pneumococci of the higher types are usually found in the sputa of patients with postoperative pneumonia. It is clearly recognized that these micro-organisms are often normal habitants of the nasopharynx and may have no etiological relationship with the pulmonary lesion. But when they are consistently encountered in large numbers in sputum, it may be reasonably assumed that there is a correlation. The problem is easily resolved when the more virulent pneumococci of lower types are present. It is only within the past few years that specific therapeutic agents have been available for use against the higher types of pneumococci. Type-specific antipneumococcic rabbit sera have been successfully employed. We have always been reluctant to use rabbit serum for these patients because of the danger of reactions in a seriously ill patient, and be-

cause, in the majority of patients, the pulmonary infection has been relatively benign. The recent advances in chemotherapy have permitted a more successful application of specific agents in the treatment of all types of postoperative pulmonary infections, particularly those due to the pneumococci. While sulfapyridine has been used widely in the treatment of pneumonia, little data have been recorded in the literature concerning its value in the therapy of postoperative pneumonia. Hinshaw and Moersch administered sulfapyridine orally in 21 cases of postoperative pneumonia, and the patients responded as well as those with primary pneumonia. It is significant that half of the number of patients treated by them became nauseated because of the drug, and it was necessary to shorten the duration of sulfapyridine therapy in a number of others because of vomiting. We have had corresponding results in the treatment of many patients with postoperative pneumonia. In patients who were unable to take the drug by mouth, a solution of the sodium salt of sulfapyridine was administered intravenously with equally satisfactory results. However, when using sulfapyridine, one is constantly apprehensive concerning the harmful effect of the nausea and vomiting upon the operative wound of the patient as well as the added discomfort involved.

Sulfathiazole is a compound that has been used more recently in the treatment of pneumococcic pneumonia. Experimental and clinical data (1, 5, 6, 7, 9, 10) indicate that sulfathiazole is at least as effective as sulfapyridine upon the pneumococcus. During the past 6 months, we have used sulfathiazole and its sodium salt in the treatment of 40 patients with primary pneumococcic pneumonia, and the clinical results were equally as good as those obtained with sulfapyridine. Sulfathiazole had the added advantage in that it was followed much less frequently by nausea and vomiting. This latter observation has prompted the use of sulfathiazole and sodium sulfathiazole in the treatment of postoperative pneumonia in patients on the surgical services of the University Hospitals. The results have been highly satisfactory, and we desire to present observations that have been made.

MATERIAL AND METHODS

A total of 22 patients was treated, including 15 males and 7 females. In all of the patients, clinical findings were elicited which fulfilled the criteria for a diagnosis of postoperative pneumonia. The patients have been divided into two groups. The first group, consisting of 6 patients, had bronchopneumonia with definite evidence of pulmonary consolidation. The 16 remaining patients had pneumonitis and atelectasis. The difficulties encountered in differentiating pneumonitis from atelectasis have already been recounted, and in the present group, we were unable to dissociate the two conditions. Therefore, we have classified this group as having pneumonitis and atelectasis. When available, sputa were examined bacteriologically, and typing for pneumococci was performed by the Neufeld method. Blood cultures were obtained before the institution of therapy with sulfathiazole.[1] An x-ray film of the chest was made as soon as the diagnosis of a pulmonary complication was considered. Bronchoscopy was performed upon one patient by Dr. Logan Leven in an attempt to remove an occluding plug of exudate from a bronchus. Sulfathiazole tablets were administered orally whenever possible. The initial dose was 2 to 4 grams, and then 1 gram every 4 hours for approximately 5 days. When the drug was given for a longer period, the doses were reduced. Sodium bicarbonate was administered along with sulfathiazole to only 4 patients. It appears very doubtful whether it is necessary to use the alkali in conjunction with sulfathiazole. There were 12 patients who were unable to take any medication orally, and a solution of the sodium salt of sulfathiazole was given intravenously. A 5 per cent solution in warm sterile distilled water was used. The initial dose was 2 to 3 grams (40 to 60 c.cm.) and then 1 gram (20 c.cm.) every 8 hours. As soon as possible, 1 gram of the sulfathiazole tablets was given orally every 4 hours. The concentrations of both the free and conjugated forms in the blood were determined by the method of Bratton and Marshall, using the Evelyn

[1]The bacteriological studies were performed by Dr. M. V. Novak and Dr. M. Levine of the Bacteriological Laboratories of the University Hospitals.

TABLE I.—POSTOPERATIVE BRONCHOPNEUMONIA TREATED WITH SULFATHIAZOLE

Case Age Sex	Operation	Site of pulmonary lesion*	Postoperative interval	Pneumococcus type	Sulfathiazole therapy					Comment
					Total dose (grams)	Days of treatment	Blood level (mgm./100 cc.) Free	Blood level (mgm./100 cc.) Conjugated	Toxic reactions	
1 37 M	Excision of pancreatic adenoma	LLL	36 hrs.	xxii	36	7	3.4 3.1	3.3 .6	None	Recovery
2 56 F	Excision of spinal cord tumor	RLL LLL	24 hrs.	—	30	8	5.1 3.0 2.9	1.5 .6 .6	None	Recovery; pleural effusion—sterile
3 30 M	Axillary dissection (malignant melanoma)	RLL	4 hrs.	xx	19	4	3.5	1.4	None	Staphylococcus albus bacteriemia; recovery
4 24 M	Appendectomy	LLL	24 hrs.	xvii	25	6	3.9	.5	Slight nausea	Recovery
5 79 F	Colostomy (carcinoma of rectum)	RLL	12 hrs.	—	7 gm. sodium 18.5 total	7	2.4 1.7 4.1	2.9 2.8 3.0	Slight nausea; hematuria	Recovery
6 63 M	Gastric resection	LLL	4 hrs.	iv	4 gm. sodium 39.0 total	8	24.8 (20 min. after giving 3 gm. i. v.) 15.2 (20 min. after giving 1 gm. i. v.) 8.0	1.3 2.0 2.1	None	Recovery

*RLL right lower lobe. LLL left lower lobe.

photoelectric colorimeter. Careful observations were made for toxic reactions to the drug[1].

RESULTS

Pertinent clinical data concerning the patients having bronchopneumonia are shown in Table I. All of the patients recovered. Pneumococci were not recovered from the blood streams of any of the patients in either group. Following the administration of sulfathiazole, the fever subsided, and there was definite clinical improvement within 24 hours. A solution of sodium sulfathiazole was given intravenously to 2 of the 6 patients. It is of interest to note the concentrations of sulfathiazole attained in Case 6. Twenty minutes after 3 grams of sodium sulfathiazole had been given, the blood level of free sulfathiazole was 24.8 milligrams per 100 cubic centimeters. There were 1.3 milligrams present as the conjugated form. Twelve hours later, 1 gram of the salt was administered, and twenty minutes later the blood concentration of free sulfathiazole was 15.2 milligrams per 100 cubic centimeters and the level of the conjugated form was 2 milligrams.

The results in the larger group of patients having pneumonitis and atelectasis are presented in Table II. The clinical response in this group was also quite definite, coincident with the administration of sulfathiazole. There was a decline in temperature, and in none of the patients was there a progression of the pulmonary lesion. Two patients in this group expired from complications unrelated to their pulmonary infections or sulfathiazole therapy. Ten of the patients received the sodium salt intravenously. One patient (Case 5) had been given a total of 5 grams of sulfapyridine by mouth, following which she experienced an episode of severe vomiting. When the vomit-

[1]More recently, we have treated a group of patients by administering a solution of sodium sulfathiazole subcutaneously. Depending upon the seriousness of the patient's illness, from 3 to 7 grams of the sodium salt are dissolved in a liter of physiological saline solution (0.3 to 0.7 per cent concentration of sodium sulfathiazole). This is given by hypodermoclysis at the rate of about 200 to 250 cubic centimeters per hour. This concentration of sodium sulfathiazole is not irritating to the tissues. In this manner, an adequate blood concentration of sulfathiazole may be maintained for 24 hours or more. To obtain a desired blood concentration of sulfathiazole quickly, 1 to 2 grams of sodium sulfathiazole are given intravenously at the same time the subcutaneous administration is started.

TABLE II.—POSTOPERATIVE PNEUMONITIS AND ATELECTASIS TREATED WITH SULFATHIAZOLE

Case Age Sex	Operation	Site of pulmonary lesion*	Postoperative interval	Pneumococcus type	Sulfathiazole therapy					Comment
					Total dose (grams)	Days of treatment	Blood level (mgm./100 cc.) Free	Blood level (mgm./100 cc.) Conjugated	Toxic reactions	
7 26 F	Cholecystectomy	RLL RML	6 hrs.	xx, xix, xxix	4 gm. sodium 18.0 total	4	3.6	.8	None	Recovery
8 20 F	Splenectomy (leucopenia)	RLL	24 hrs.	xix, xi	12 8	2 2	2.4 1.6	.4 .8	Nausea	Recovery. 2 attacks—one 24 hrs. postoperative; 2d 7 days postoperative. Bronchoscopy 1st attack
9 70 F	Cholecystectomy	RLL LLL	48 hrs.	—	2 gm. sodium	1	3.2	.6	None	Recovery after 5 gm. sulfapyridine severe vomiting
10 27 M	Plastic craniotomy	RLL	6 days	xxxi	38	7	4.3	.3	None	Recovery
11 40 M	Gastric resection	RLL LLL	7 hrs.	iv	11 gm. sodium	5	6.5 3.1	2.0 1.1	None	Recovery
12 68 M	Colostomy (intestinal obstruction. Fractured femur)	RLL LLL	5 hrs.	—	6 gm. sodium in 2 doses: 4 gm. and 2 gm.	6			None	E. coli bacteremia Epididymitis. Died
13 53 M	Gastric resection	LLL	24 hrs.	vi	8 gm. sodium 13.0 total	5	2.0 1.3 2.6	1.0 .8 1.0	None	Recovery
14 66 M	Perforated gall bladder, cholecystectomy	RLL LLL	24 hrs.	—	6 gm. sodium	2	1.6	.4	None	Recovery
15 41 M	Appendectomy, cholecystectomy, choledocholithotomy, choledochostomy	RLL	36 hrs.	xi	3 gm. sodium 33.0 total	7	1.4 4.8 4.2	.2 .8 1.0	None	Recovery
16 21 M	Appendectomy	LLL	5 hrs.	xxii	6 gm. sodium 21.0 total	5	4.2	.5	None	Recovery
17 66 F	Gastric resection	RLL LLL	7 hrs.	xv	8 gm. sodium	3	5.6	1.2	None	Recovery
18 35 M	Intervertebral discectomy	RLL	6 hrs.	xxiv	37	7	5.9 5.1	.2 .6	None	Recovery
19 39 F	Nephrostomy, pelviolithotomy Inc. abscess thigh	RLL	48 hrs.	—	43	8	3.2 5.7	.4 1.0	Nausea; dermatitis	Recovery. Rash on eighth day
20 44 M	Gastric resection	RLL	6 hrs.	—	16 gm. sodium	6	2.4 4.7	.8 .3	None	Recovery
21 57 M	Appendectomy	RLL	12 hrs.	xv	8	5	1.2 1.4	2 1.0	None	Evisceration. Died
22 55 M	Appendectomy, cholecystectomy	RLL	12 hrs.	—	52	14	9.8 9.8 7.1	2.0 3.7 .8	None	Recovery

*RLL right lower lobe.
LLL left lower lobe.
RML right middle lobe

ing had subsided, sodium sulfathiazole was given intravenously with no untoward effects.

It is difficult to state at the present time what is the desirable blood concentration of sulfathiazole for the treatment of patients with postoperative pneumonia. Satisfactory clinical results were obtained in the present series with levels of free sulfathiazole from 3 to 5 milligrams per 100 cubic centimeters of blood.

The toxic manifestations from sulfathiazole were less than those encountered following the use of sulfapyridine. Smaller amounts of the circulating sulfathiazole were present as the conjugated form as compared to sulfapyridine. Four of the patients complained of nausea during the course of treatment, but in none was it severe enough to necessitate withdrawal of the drug. One patient developed a gross hematuria without other evidence of impaired renal function. In 1 individual an erythema nodosum-like eruption appeared on the extremities after 8 days of sulfathiazole. The lesions subsided when sulfathiazole therapy was stopped.

VALUE OF SULFATHIAZOLE THERAPY

We do not desire to imply that the recovery of the patients in this series was due entirely to the use of sulfathiazole. Conclusions concerning the therapeutic effectiveness of the drug can be based only upon the results obtained in a much larger series of cases. The important point that we wish to make is since it is often exceedingly difficult to make a clinical distinction between an early lobar or lobular pneumonia and pneumonitis and/or atelectasis in an acutely ill patient, sulfathiazole is a specific antipneumococcal agent that may be given with a reasonable degree of safety. At the present time, we do not hestitate to administer the drug to any patient with a relatively benign pulmonary infection but in whom a number of other factors have reduced his resistance so that a progression of the lesion would tip the balance against his recovery. Sulfathiazole is of especial value in the therapy of postoperative pneumonia in that it may be readily administered intravenously in the form of sodium sulfathiazole.

SUMMARY

1. The term "postoperative pneumonia" is applied to patients having a lobular or lobar type of consolidation, or a purulent bronchitis with a low-grade type of parenchymal inflammation usually accompanied by atelectasis. The pneumococcus is the etiological agent in the majority of cases.

2. Twenty-two patients with postoperative pneumonia were treated with sulfathiazole and/or sodium sulfathiazole with satisfactory clinical results.

3. Since sulfathiazole causes less nausea and vomiting, and appears to be equally as effective for pneumococcic pulmonary infections as sulfapyridine, it is recommended that sulfathiazole or sodium sulfathiazole should be used in the treatment of postoperative pneumonia.

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SULFONE CHEMOTHERAPY IN HEMATOGENOUS OSTEOMYELITIS

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THE prognosis of any single case of acute osteomyelitis depends on many variable factors. Some of these, such as the time and extent of operation, and the type of after-care, can to a great extent be controlled by the surgeon; others, such as the strain and virulence of invading organisms, the previous medical condition of the patient, his powers of resistance, and the intensity of the local tissue reaction, are altogether beyond his control. Therefore, in considering the effect of any procedure on the course of the disease, one must attempt to evaluate that procedure by reasonably simple and tangible criteria. With this premise in mind, 20 cases of hematogenous osteomyelitis were reviewed in which chemotherapy with sulfone derivatives was used as part of the treatment. Aside from the use of these drugs, the patients were treated no differently than were other patients with similar conditions before the introduction of the drugs or, in a number of instances, concurrently. From time to time different types of bone excision have been used, such as drill holes, cortical windows or bone wedges, but in all instances the general approach of establishing adequate drainage at the optimal time, followed by the Orr treatment or a modification thereof to suit the individual case, was carried out.

The present series while not large represents 3 years of experience with carefully studied cases. During this period the drugs have been used on many more cases, such as secondarily infected wounds, which were not included in the investigation. To the writer's knowledge, no comparable series has as yet been reported. Mitchell, in 1938, published his results in 5 cases of Staphylococcus aureus osteomyelitis treated by uleron (Bayer's sulfanilamide); Weidekamp, in the same year, discussed the use of prontosil in tuberculous and nontuberculous osteomyelitis, including 1 case of the latter. Many of the recent papers which review the general subject of the clinical use of sulfone derivatives, mention their application to osteomyelitis without discussing their effect on the course of the disease other than the control of general sepsis.

The effect of sulfone chemotherapy on general sepsis in streptococcus and staphylococcus infections is being adequately studied by many investigators and its present value is fairly well established. Likewise the pathology and general course of osteomyelitis has been thoroughly described by Lexer, Wilensky (9), Key, Phemister, Brown, and many others, and also requires no further discussion at this time. For present purposes the objective has been limited to a study of the effect of sulfone chemotherapy added to standard surgical procedures on (1) the course of the local bone pathological process, (2) on recurrence, and (3) on metastases. It is common knowledge among those who have watched the natural course of the disease that the establishment of drainage, even early in the disease, does not necessarily prevent the progressive involvement of bone over a more or less limited area of the adjacent shaft. This is easily demonstrated by a series of x-ray films taken during the postoperative period. In successful cases, this area gradually regains its normal appearance. In widespread lesions, the reorganization of bone structure in healed cases may not be completely normal in structure, but still consists of well established trabeculae and canals. If the addition of sulfone medication to the treatment could be shown either to eliminate or significantly retard this cycle of postoperative necrosis in a large percentage of cases, then its effect on the local infection would be demonstrated. If cases so treated showed a considerable decrease in recurrences or in metastases, its value would be evident. The cases in this series were analyzed with these criteria in mind.

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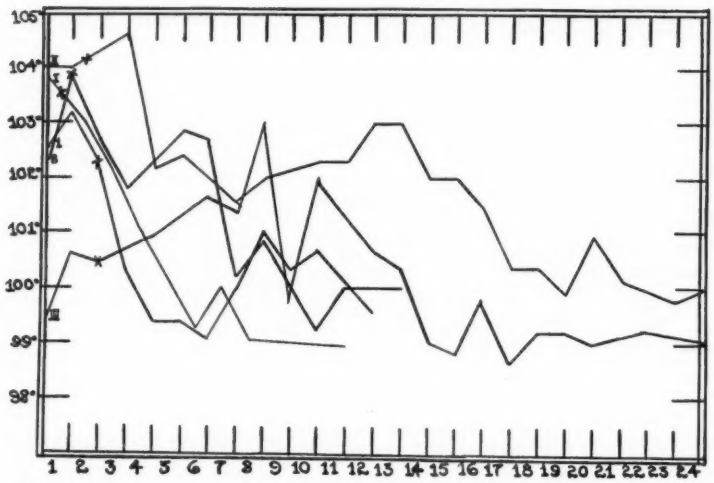

Chart 1. Temperature levels. *X*, start of use of drug; *I*, *II*, *III*, sulfanilamide; *1*, *δ*, sulfapyridine.

In the earlier cases of this series, as in Mitchell's cases, sulfanilamide was used for both staphylococcal and streptococcal infections. As the derivative sulfapyridine and later sulfathiazole appeared, these were used on staphylococcal cases, and sulfanilamide was reserved for the beta hemolytic streptococcus. In several instances, combinations running either simultaneously or in sequence were used. In general, it may be stated here, that in the earlier cases in which sulfanilamide was used in staphylococcal osteomyelitis, patients recovered in a manner very similar to that of later cases. There was the same drop in temperature, the same cycle of bone involvement, and the same general recovery. These cases resembled those reported by Mitchell. The present series shows the usual variety of age, duration, location, operative time, and other factors as would be found in any concurrent or preceding series. In discussing these cases, the significant facts will be mentioned at some length. The corroborating details can be studied only by examining the data of the individual cases summarized.

EFFECT ON TEMPERATURE

One of the dramatic manifestations of the use of sulfone derivatives in the various infections has been the sudden drop in temperature which frequently follows. This is especially remarkable in such infections as pneumonia, streptococcal sore throat, and meningitis. Chart 1 shows a composite picture of 6 characteristic temperature charts. Reference to similar charts published by Wilensky (10) on patients treated without sulfone medication, and confirmed by our own charts in similar cases, demonstrates no significant alteration. In most instances, following the establishment of drainage in uncomplicated cases, the temperature does drop from a relatively high level to a lower. Occasionally, the drop is to normal in a few days; usually it falls to between 100–101 degrees and gradually subsides to normal in a week or two in the less extensive infections, or in a longer period in the more widespread cases. In the present series, the temperature readings did not as a group deviate from groups in which sulfone chemotherapy was not used. The temperature readings varied with the local infection and its surgical aspects, that is, drainage, area of infection, and intensity of tissue reaction. In several streptococcal cases in which patients were not operated upon, the temperature fell soon after the application of a plaster-of-Paris bandage, and the customary dose of sulfanilamide given

by mouth, but not more rapidly than has occurred in similar cases in which patients were treated only by plaster.

WOUND HEALING TIME

The length of time of healing of the operative wound in these cases was not noticeably shortened. Here again it varied with the customary rules of surgical practice, that is, the extent of wound surface, and persistence of drainage. There was no noticeable difference in the quality or quantity of granulation tissue.

BONE NECROSIS

This phenomenon was studied in some detail. Figures 1 to 3 show characteristic cycles in several of the cases which were adequately drained at an optimal time. The patients were relieved after operation and by all the customary objective and subjective observations went through the usual course of an uneventful recovery from acute hematogenous osteomyelitis. Sulfone therapy did not to any measurable degree retard or restrain the completion of the cycle of bone absorption and restoration in these cases. There were 7 such cases in the present series. A number of cases, especially in the younger age group, recovered without bone changes, after simple incision of subperiosteal abscesses. These cases followed the course and time elements of such patients treated similarly without sulfone chemotherapy.

RECURRENCES

Recurrence in this study refers to local reactivation of a clinically healed lesion as distinct from an exacerbation of an unhealed area, or the late appearance of a metastatic focus. In this series there have already been two recurrences, both in staphylococcal infections. In neither case was the recurrence operated upon. In one instance it subsided in a week with wet dressings and sulfapyridine; in the other, wet dressings were enough. The latter was, on his first admission for sulfone therapy, an acute recurrence of an old osteomyelitis. The infection was not eradicated by the drug.

METASTASES

Metastatic foci were observed during the period of treatment or soon thereafter in 2 cases. Here again the percentage is about the same as in larger series treated without sulfone derivatives. In one very active staphylococcal infection, with severe septicemia, involving primarily the clavicle, there were metastases to both humeri, and the left tibia. There was also a widespread papulopustular skin eruption (3). In another staphylococcal infection of the femur, secondary foci appeared about the ankle and alveolar process.

TOXIC MANIFESTATIONS

In one of the earliest cases in which sulfapyridine was used the patient died of a typical agranulocytosis. The drug was given for 5 days beginning on the day of admission, which was also the day of operation. On the fifth day, temperature was normal, and the patient in excellent condition. It was decided to continue the drug in the hope of definitely eliminating the staphylococcal infection. Five days later, the white blood count was still 10,600; 2 days later it had dropped to 4,000, with 72 per cent polymorphonuclears. The drug was stopped. Next day the count was 3,400 cells, 24 per cent polymorphonuclears. Six days later, during which period daily transfusions and full doses of pentonucleotide were given, the white count fell to less than 300 cells, all of which were lymphocytes, and the patient died. In all, the patient had been given 93 grams of sulfapyridine between March 28 and April 13. This case has been reported in detail elsewhere (7). Aside from this instance there were no other serious toxic manifestations. In several cases the drug was stopped because of nausea or excessive blueness. The latter symptom is no longer dreaded as at first, but marked nausea is still taken seriously.

BLOOD CULTURES

In 7 cases the blood showed Staphylococcus aureus on culture; in 2 cases, Streptococcus haemolyticus appeared. In 2 cases both of these organisms appeared together, and in 9 cases the blood showed no organisms at all. In all but 1 case showing positive blood cultures, these were sterile from 2 to 5 days after the institution of treatment, regardless of the state of healing of the local infection. The only case in which the blood cultures re-

mained positive for a considerably longer period was in the patient who suffered multiple metastases and the generalized pustular eruption.

ANALYSIS OF RESULTS

All the cases were treated according to standard surgical indications. The addition of sulfone chemotherapy was supplementary. Of the 3 patients not operated upon, 1 showed Streptococcus haemolyticus in the blood stream; the blood cultures of the 2 others were negative. One case involved the pubis, another the edge of the astragalus, and the third was an acute recurrence of an old osteomyelitis of the femur without sequestrum. All 3 of these patients would have been handled similarly even without chemotherapy, and compared to similar cases the condition might well have subsided without operation. Whether the outcome was influenced by the sulfone therapy employed is conjectural, but the length of time involved in their resolution as compared to that in similar cases in which patients were treated conservatively without the use of such drugs was not markedly altered. In uncomplicated cases in which the condition subsided shortly after operation, no treatment was used other than surgical aftercare. In cases in which the infection did not subside promptly, blood transfusions were given freely. In several severe cases of staphylococcemia, along with sulfone therapy, staphylococcic antitoxin was used in large amounts. It must be noted that had these infections responded to the drug, the prolonged use of additional forms of therapy would not have been indicated.

However, it is necessary to remark on certain phases of sulfone therapy in connection with this problem in order not to present a too one-sided observation. Unquestionably, the instances of acute osteomyelitis following ear, nose, and throat infections have been decreased since the sulfone drugs have been used in their treatment. Furthermore, those patients whose local lesions do not subside promptly after operation do not present the characteristic general septic appearance that was so often seen in past years. The bacteriemia can unquestionably be controlled during this period. However, it must be noted, that, after the drug is stopped, the local focus, if it persists, can still be the source of metastases. Furthermore, it cannot be disproved that certain of the metastases occurred even during the time the drug was used. Temperature levels are kept at a lower plane during the acute febrile state when sulfone therapy is used. It is important to recognize this fact to avoid neglecting still undrained areas. In several instances, a temperature level would rise during a period when the drug was withheld, and fall to a lower level when it was again used, thus indicating a specific antipyretic action.

SUMMARY OF CASE HISTORIES

CASE 1. Male, aged 17 years, was admitted to the hospital February 4, 1939, because of pain near the left ankle, of 6 days' duration. Wet dressings were applied. From February 10 to 13, 10.6 grams of sulfanilamide were given. On February 13, a subperiosteal abscess over the lower end of the tibia was incised and packed with vaseline gauze. On February 15, 370 cubic centimeters whole blood transfusion was given. Blood culture on February 13 showed Staphylococcus aureus α. February 14, hemoglobin was 58 per cent; red blood cells numbered 3,650,000; white blood cells, 11,300. February 16, hemoglobin was 72 per cent. March 10, hemoglobin was 76 per cent; red blood cells, 4,470,000; white blood cells, 10,500.

Patient was readmitted on March 6, 1939 at which time there was a recurrence of tenderness and swelling at the ankle. The wound had healed. Temperature was 101 degrees, but subsided with the administration of wet dressings and the administration of sulfapyridine (22 grams were given from March 8 to 15).

CASE 2. Male, aged 11 years, was admitted to the hospital February 3, 1939, with pain in the right knee for 10 days. He had fever. X-rays films showed early cortical bone lesion at the metaphysis of the tibia. On February 5, a subperiosteal abscess was incised and packed. From February 4 to 7, 20 grams of sulfanilamide were given. On February 3, hemoglobin was 60 per cent; white blood cells, 12,700. February 17, hemoglobin was 60 per cent, white blood cells, 17,600. March 1, hemoglobin was 67 per cent. February 22, a 500 cubic centimeter blood transfusion was given. Blood culture on February 3 showed Staphylococcus aureus α; on February 5 it was sterile.

On March 3, patient was discharged with a draining sinus. On July 3, 1940, the wound was finally healed. During the time of treatment, serial x-ray films showed an increase in the area of bone involvement through the upper fourth of the tibial shaft, followed by gradual regeneration and increased density of bone substance.

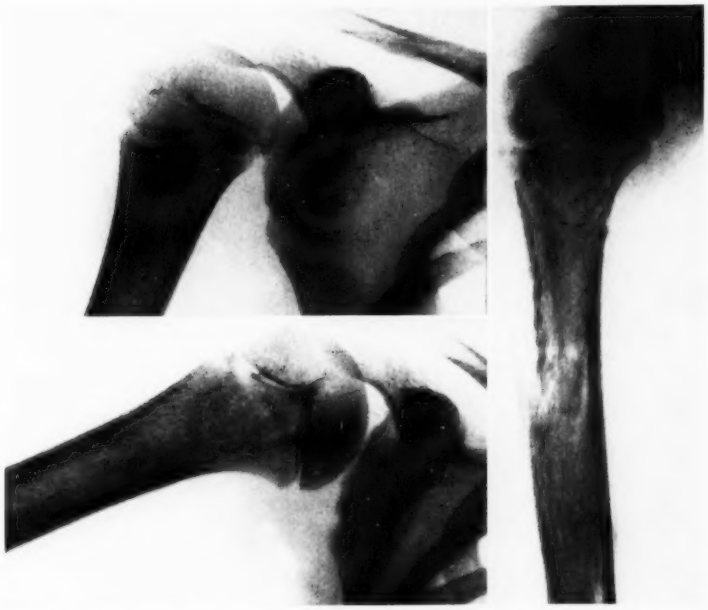

Fig. 1. Case 7. Left above, before operation, and left below and right, 2 months after operation.

CASE 3. Female, aged 66 years, was admitted to hospital February 7, 1938, for pain in the upper end of the tibia; duration, 1 month. Nineteen years previously patient had been operated on for a bone abscess in this area but had remained symptom-free ever since. February 16, a cortical window was removed at the level of the lesion in the upper end of the tibia. From February 21 to 26, 10 grams of sulfanilamide were given. On March 18, a plastic closure of the wound was performed. Hemoglobin remained around 80 per cent during hospital stay. Blood culture showed Streptococcus hemolyticus β. Before discharge in April, 1938, the wound had reopened and was draining.

CASE 4. Male, aged 1½ years, was admitted to the hospital April 13, 1939, with pain in the right wrist. and with fever and malaise of 1 day's duration. On April 15, a subperiosteal abscess over the lower end of the right radius was incised and packed. On April 22, the operative incision was enlarged and repacked. From April 15 to 23, 16 grams of sulfanilamide were given. From April 20 to May 6, 32 grams of sulfapyridine were given (from April 20 through the 23rd, both were given concurrently). During this time 10 transfusions of 250 to 500 cubic centimeters each were given, 300,000 units of staphylococcus antitoxin, 40 cubic centimeters of scarletinal convalescent serum, and large amounts of intravenous glucose and calcium. On April 13, white blood cells numbered 23,000; April 17, white blood cells, 6,000; April 18, white blood cells, 4,500; with normal differential. April 28, white blood cells numbered 3,400. Blood culture showed Staphylococcus aureus α, and Streptococcus hemolyticus β.

Patient was readmitted on August 19, 1939, with a draining sinus and rise in temperature. He was discharged with subsidence of symptoms. On March 28, 1940, the patient was readmitted because of extensive bone necrosis of the lower two-thirds of the radius. A diaphysectomy was performed and a bone transplant inserted.

CASE 5. Male, aged 9 years, was admitted to the hospital April 26, 1940, with pain in the groin; of duration of 8 days. He had fever. X-ray films showed an osteomyelitic lesion in the right pubis. From April 29 to May 2, 13 grams of sulfanilamide were given. From May 2 to 9, 27 grams of sulfathiazole were given. On April 26, hemoglobin was 75 per cent; white blood cells, 14,500; sedimentation rate, 22 minutes. Blood culture was negative. In September, 1940, x-ray films showed some localized process in the pubis with evident regeneration of bone in that area.

CASE 6. Female, aged 58 years, was admitted to the hospital on September 9, 1939, with osteomyelitis of the femur. Symptoms had been present for 3 weeks. This was an acute recurrence of an old symptom-free osteomyelitis. Wet dressings were applied, and 10 grams of sulfapyridine were given from September 9 to September 12. Wound culture showed

Fig. 2. Case 4. Pre-operative, postoperative views and healed.

Staphylococcus aureus α. Hemoglobin on September 9 was 94 per cent; white blood cells, 8,500, with normal differential. Symptoms subsided and patient was discharged. Three weeks later there was a similar recurrence which subsided under wet dressings without the use of sulfone drugs. Patient has been symptom-free ever since.

CASE 7. Female, aged 10 years, was admitted to the hospital on March 4, 1939, with osteomyelitis of the humerus; duration of symptoms, 4 days. Initial x-ray films showed faint haziness about the upper metaphysis. On the day of admission, a subperiosteal abscess was packed with vaseline gauze after it was incised. Seventy-two grams of sulfapyridine were given from March 4 to March 17. Blood culture showed Staphylococcus aureus α on March 5, and was negative on March 15. On March 4, the white blood cell count was 12,000; hemoglobin, 65 per cent. On March 10, the white blood cell count was 8,400; hemoglobin, 62 per cent. On March 13, the white blood cell count was 8,600; hemoglobin, 60 per cent. On March 18, the hemoglobin was 58 per cent, and a transfusion of 350 cubic centimeters of blood was given. Serial x-ray films taken during the stay at the hospital showed progressive destruction of the upper third of the humerus. Patient was readmitted to the hospital on November 27, 1939, with two draining sinuses. On the following day a sequestrum was removed. On April 3, 1940, the patient still presented two draining sinuses. X-ray films showed increasing density of the lesion in the bone.

CASE 8. Female, aged 32 years, was admitted to the hospital on August 22, 1939, with pain in her chest of 2 days' duration. X-ray examination revealed osteomyelitis of a rib. From August 23 to August 25, 10 grams of sulfapyridine were given. On August 29, the bone abscess was incised and packed. Wound culture showed Staphylococcus aureus α and Streptococcus hemolyticus β. Hemoglobin on August 22 was 92 per cent; white blood cells, 7,200. On August 30, hemoglobin was 88 per cent. Blood culture was negative. Two months later the wound was still draining and the x-ray showed no change in the local lesion.

CASE 9. Male, aged 12 years, was admitted to the hospital on August 14, 1939, with osteomyelitis of the sternum; duration of symptoms, 4 days. Twenty-four grams of sulfapyridine were given from August 14 to August 15. On August 17, the lesion in the sternum was incised and drained. Blood culture showed Staphylococcus aureus α and Streptococcus hemolyticus β. On August 14, the hemoglobin was 95 per cent; red blood cells numbered 5,500,000; white blood cells, 20,000; sedimentation rate was 2½ hours. On August 16 the white blood cells numbered 8,000. On December 14, 1939, the wound was entirely healed.

CASE 10. Male, aged 28 years, was admitted to the hospital on July 17, 1939, with osteomyelitis of the fibula; duration of symptoms, 1 week. This was a recurrence of a lesion active 20 years previously and asymptomatic since that time. On July 18, a diaphysectomy was performed. From July 19 to July 22, 16.2 grams of sulfanilamide were given. Hemoglobin was maintained between 55 and 65 per cent during the hospital stay. On August 18, a 500 cubic centimeter blood transfusion was given. Wound culture showed Staphylococcus aureus α. Following the operation, the wound drained. The temperature persisted at 100 degree level for over a month.

CASE 11. Male, aged 33 years, was admitted to the hospital on March 27, 1939, with pain about the hip; duration of symptoms, 2 weeks. A diagnosis of osteomyelitis involving the ileum and upper end of the femur was confirmed by the x-ray. On March 30, the bone lesion was incised and packed. From March 27 to April 1, 21 grams of sulfanilamide were given. The bone incision was further extended on April 27 because of persistent drainage. Blood culture was negative and wound culture showed Staphylococcus aureus α. On admission, the patient was acutely ill with a temperature of 104 degrees F. This fell after the first operation but rose to 103.6 degrees F. 1 week later, and continued to rise and fall until the second operation was performed. On March 27, hemoglobin was 72 per cent; white blood cells, 19,700. On April 1, hemoglobin was 64 per cent; white blood cells, 19,700. The wound was still draining at the time of discharge and there was no sign 2 months later of any bone regeneration.

CASE 12. Male, aged 10 years, was admitted to the hospital on March 28, 1939, with osteomyelitis of the upper end of the humerus. Duration of symptoms was 3 days. On the day of admission, the bone was incised and the wound was packed. Blood cul-

ture on March 28 showed Staphylococcus aureus α and was negative on April 2. One hundred and ninety-three grams of sulfapyridine were given. On March 28, the hemoglobin was 95 per cent; white blood cells, 16,700. On March 30, white blood cells numbered 11,000. On April 5, white blood cells numbered 11,800. On April 10, the white blood cells were 10,600. On April 12, the cell count had dropped to 4,000, with 72 per cent polymorphonuclears, and on April 14 to 3,400, with 24 per cent polymorphonuclears. On April 19, the white blood cells were counted below 300 with 100 per cent lymphocytes. Beginning on April 14, blood transfusions of from 250 to 500 cubic centimeters were given daily and 10 cubic centimeters of pentonucleotide were given four times a day. Patient died on April 20, 1939.

CASE 13 (3). Male, aged 12 years, was admitted to the hospital on December 16, 1938, with osteomyelitis of the clavicle; duration of symptoms, 3 days. The bone lesion was incised and packed on the day of admission. Patient reacted badly, with prolonged high temperatures. From December 17, 1938, to January 20, 1939, 142 grams of sulfapyridine were given. Blood culture showed Staphylococcus aureus α (70 colonies per c.cm.). Patient developed a generalized pustular eruption during the postoperative period, with metastases in both humeri and the left tibia. These metastases subsided with wet dressings. During the course of the illness, x-ray films showed progressive destruction in the primary bone focus and the metastases. During this period, in addition to sulfapyridine, 90,000 units of staphylococcus antitoxin were given, as well as a total of 2,750 cubic centimeters of blood. On December 16, 1938, the white blood cells numbered 8,000. During the acute illness the number rose to 23,000, and toward the end fell to 4,000. Patient was finally discharged with all wounds healed. To date, x-ray films have showed progressive regeneration of the bone lesions.

CASE 14. Male, aged 12 years, was admitted to the hospital on June 21, 1938, with osteomyelitis of the ulna; duration of symptoms, 3 days. A subperiosteal abscess over the ulna was incised and packed on June 27, 1938. Wound culture showed Staphylococcus aureus α. Blood culture was negative. The x-ray films taken on admission showed no signs of bone involvement. The wound continued to drain. On July 25, x-ray films showed extensive osteomyelitis of the ulna. On July 27, two-thirds of the ulna was resected; the bone was boiled according to the technique of Orell, and reimplanted. On October 14, 1938, part of the reimplanted bone which had formed a sequestrum was removed. The wound continued to drain through sinuses for many months. On March 28, 1940, the wounds were healed. X-ray films showed no union between the remaining bone implant and the residual of the ulnar.

CASE 15. Male, aged 75 years, was admitted to the hospital on October 22, 1938, with osteomyelitis

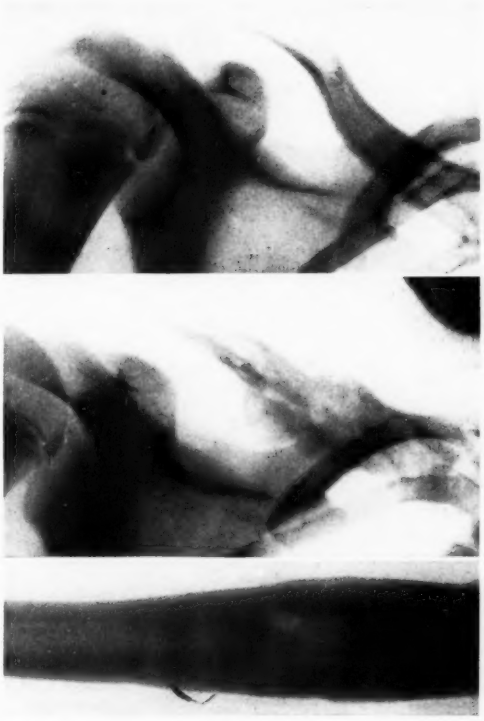

Fig. 3. Case 13. Roentgenograms taken before operation, 2 weeks after, and later showing metastasis to humerus.

of the humerus; duration of symptoms, 1 month. The bone was incised and packed on October 22. From October 23 to October 27, 9 grams of sulfanilamide were given, since the wound culture showed Staphylococcus aureus α. Blood culture was negative. The patient developed bronchopneumonia and died on October 28, 1938.

CASE 16. Male, aged 12 years, was admitted to the hospital on March 2, 1938, with osteomyelitis of the femur; duration of symptoms, 6 days. On March 3, a subperiosteal abscess over the lower end of the femur was incised and packed. Wound culture showed Staphylococcus aureus α. From March 2 to March 4, 7 grams of sulfanilamide were given. In spite of that, the temperature remained high. On March 2, hemoglobin was 80 per cent, red blood cells, 5,000,000; and white blood cells, 17,000. On March 4, the number of white blood cells dropped precipitately to 5,150. Staphylococcus antitoxin, 27,000 units, as given the next day, as well as a blood transfusion of 900 cubic centimeters. During the postoperative period, the patient developed infectious metastases over the right fibula and in the alveolar process. The alveolar process was relieved

by dental surgery and the fibular process subsided with wet dressings.

CASE 17. Male, aged 14½ years, was admitted to the hospital on September 3, 1938, with osteomyelitis of the upper end of the humerus; duration of symptoms, 2 days. On September 4, a bone section was removed at the site of lesion and the wound was packed. Seventy-five cubic centimers of sulfanilamide were given intravenously in repeated doses on September 3 and 4. The hemoglobin remained about 85 per cent from September 3 to September 22, with two intervening examinations. A blood transfusion of 500 cubic centimeters was given during the postoperative period. Blood culture on September 3 showed Staphylococcus aureus α, and on September 6 was sterile. During the postoperative period, in spite of immobilization, bone involvement as shown by x-ray studies extended throughout the upper third of the humerus. The wound subsequently healed and later x-ray films have shown increasing regeneration within the lesion.

CASE 18. Female, aged 14 years, was admitted to the hospital on January 4, 1938, with osteomyelitis of the ulna; duration of symptoms 5 days. X-ray films were negative concerning any bone involvement at this time. A subperiosteal abscess was incised and packed on January 4. On January 4 and 5, 4.5 grams of sulfanilamide were given. Hemoglobin varied from 65 to 70 per cent during the hospital stay. A blood transfusion of 500 cubic centimeters was given. Blood culture was negative, and the wound culture showed Staphylococcus aureus α. During the postoperative period, serial x-ray films showed progressive bone involvement. The wound healed and subsequent x-ray examination showed gradual regeneration of the bone.

CASE 19. Male, aged 13½ years was admitted to the hospital on July 3, 1937, with osteomyelitis of the femur; duration of symptoms, 4 days. In this case 15 grams of sulfanilamide were given between July 8 and July 15. Blood culture was negative. The temperature remained elevated to 104 degrees F. during the early period of sulfone therapy. On July 13, the bone was incised and packed, after which the temperature dropped to almost normal within 3 days. Wound culture showed Staphylococcus albus. On July 7, the hemoglobin was 80 per cent, and the white blood cells 19,000. On July 13, the hemoglobin was 78 per cent, and the white blood cells 32,700, showing toxic granules. On July 16, the hemoglobin was 76 per cent, and the white blood cells 14,800. X-ray films showed postoperative extension of the area of bone involvement. The wound subsequently healed and has remained quiescent. Later x-ray examination showed progressive bone regeneration.

CASE 20. Female, aged 3½ years, was admitted to the hospital on May 12, 1940, with osteomyelitis of the posterior region of the talus; duration of symptoms, 1 day. No operation was performed. From May 13 to May 17, 4.3 grams of sulfanilamide were given. Blood concentration of sulfanilamide on May 14 was 4.2 milligram per 100 cubic centimeters. A plaster boot was applied. Blood culture on May 12 showed Streptococcus hemolyticus; was sterile on May 14, and again sterile on June 6. Serial x-ray films showed a cycle of bone regeneration. Patient has had no recurrence since that time.

CONCLUSION

On the basis of 20 cases of hematogenous osteomyelitis, and until the above observations are invalidated by a larger series, the following conclusions are presented.

1. The addition of sulfanilamide, or sulfapyridine, to the treatment of hematogenous osteomyelitis has not significantly altered the general course of bone pathology, rate of recurrences, or metastases.

2. In a series of 20 cases representing all degrees of severity, there was only 1 death and that due directly to sulfapyridine. In several instances toxicity was favorably influenced, and the use of the drug was probably the determining factor between life and death.

3. In the treatment of hematogenous osteomyelitis sulfone chemotherapy is not a substitute for surgical judgment, operative technique, or meticulous after-care.

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EXPERIMENTAL COLLATERAL CIRCULATION OF THE HEART

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ALERT surgeons in their endeavor to relieve Pick's disease by removing constricting pericardial adhesions encountered blood vessels of considerable size traversing between the myocardium and the adhesions (1). This observation led to the belief that possibly a new blood supply to the heart could be produced by surgically grafting various tissues to the heart. Consequently, skeletal muscle, omentum, fat, mediastinal tissue, lung, etc. were implanted on the heart and, in some instances, vascular connections were demonstrated (2). The most recent of these works is that of H. B. Burchell who concludes: "The possibility that small vascular connections between a graft and the heart might develop to a functioning degree cannot be denied, but in experiments seemingly favorable to such a result it has not occurred."

The natural processes of life bring about the narrowing of the lumina of the coronary vessels and too frequently early dire results are not readily produced in experimental animals. Acute and chronic mechanical constrictions of these arteries have been made in the laboratory and the ensuing infarct, degeneration, and thinning of the myocardium and papillary muscles have been observed. To offset this pathological process various grafts were implanted on the experimental heart with the hope that new blood vessels large enough to carry sufficient blood would develop to nourish the ischemic areas. One must with reservation compare this condition produced in animals having young healthy hearts, adequately nourished and possessing the physiological means of repair and construction, to the human suffering from coronary sclerosis who has none of these in such abundance. Nevertheless on the basis of careful experimental work of this nature, surgeons have attempted and with some measure of success treated these diseased hearts. I refer particularly to Beck (3) in this country and O'Shaugnessy of London, England. The former prefers to use the pectoralis major muscle and the latter the omentum as the tissue of choice for grafting.

The writer in a series of experiments has taken the omentum, intercostal muscles, lung, and internal mammary artery as grafts and after an interval of 3 to 6 weeks, partially interrupted the flow of blood through the main branches of both coronary arteries. Electrocardiograms revealed recent infarcts and then, as time went on, a gradual improvement appeared until the tracings approached those of a normal animal. The question which arises resolves itself into two distinct problems: Has the graft contributed to the healing process by delivering blood to the heart or have the normally present anastomoses enlarged and carried the necessary nourishment? It is a known fact that a considerable communication between right and left coronary arteries exists especially at the apex and that numerous anastomoses are present at the bases of the great vessels between pericardial and coronary vessels.

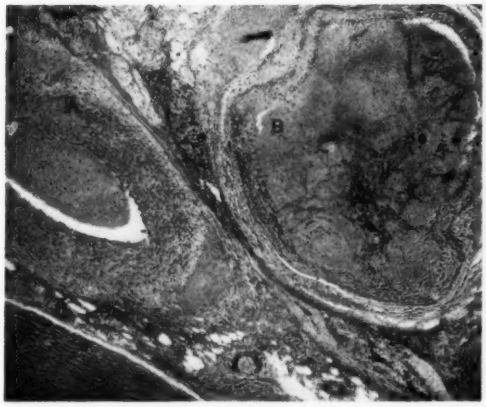

Fig. 1. *A*, coronary artery; *B*, internal mammary artery.

From the Surgical Division, University of Wisconsin.

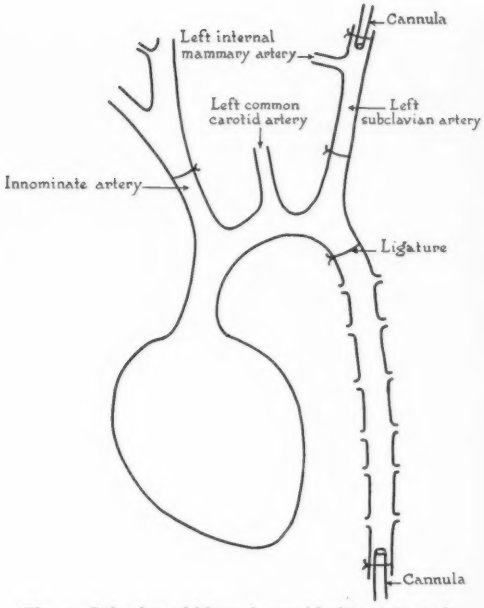

Fig. 2. Injection of bismuth oxychloride and acacia.

Several special conditions were noted in the postmortem examination of the dogs used in these studies. When muscle was grafted to the heart the graft became quite stiff and the heart action was not free although this apparently did not inconvenience the animal. Omental grafts remained soft and pliable leaving the heart to act more normally.

Microscopic studies of blocks of tissue removed showed some degeneration of skeletal muscle, and in all cases an avascular fibrous layer between graft and myocardium (Fig. 5).

Opaque masses entered the coronary tree on several occasions only when the pericardium was not removed. The material reached the coronary arteries through the normally present but enlarged anastomoses between the pericardiophrenic branches of the internal mammary artery and the coronary arteries and through small anterior branches of the thoracic aorta which give off branches to the lateral and posterior surface of the parietal pericardium. These small anterior branches also anastomose freely with bronchial, phrenic, intercostal and internal mammary arteries.

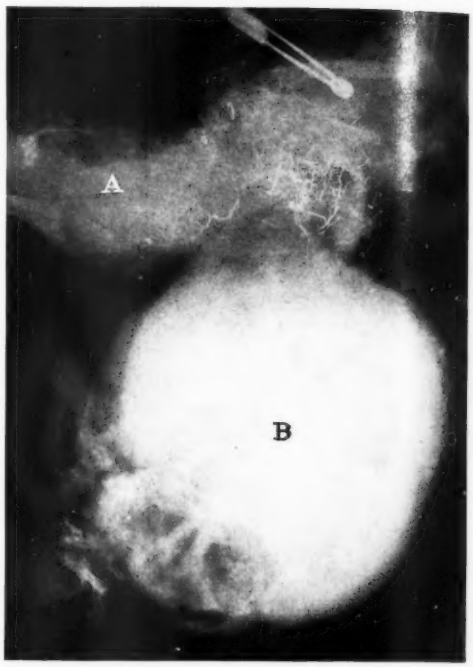

Fig. 3. This plate represents a case in which the pericardium was removed. The graft is fairly vascular but none of the opaque material entered the coronary vessels. *A*, intercostal muscle graft; *B*, heart.

Anastomosis of left internal mammary artery to coronary artery. Our first experiments were two attempts to anastomose directly the left internal mammary artery to the descending ramus of the left coronary artery. Both of these procedures failed. The photomicrograph (Fig. 1) shows the close proximity of the two vessels but there is no communication between them. The walls are practically touching each other with only a small strip of exudate between. The coronary artery, *A*, is patent. The internal mammary artery, *B*, contains a recent thrombus. With the use of heparin and an improved technique this type of anastomosis might be possible.

Suture of intercostal muscle and vessels to the anterior surface of the heart. The anesthesia consisted of intratracheal ether oxygen mixture and artificial respiration. In these experiments two types of grafts were used; one with a pedicle medial and the other with the pedicle

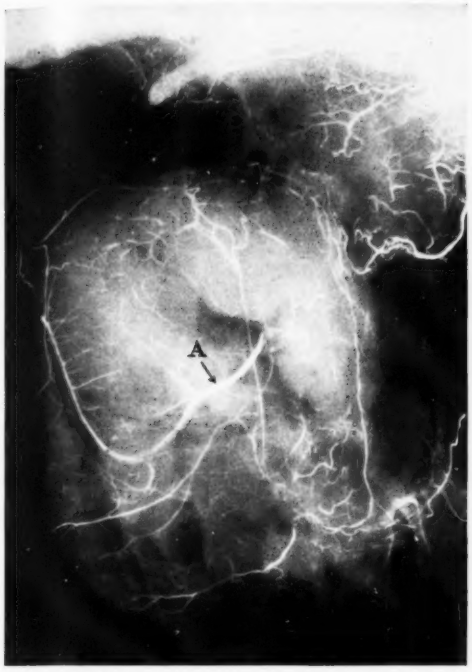

Fig. 4. This plate represents a case in which the pericardium was not removed. As the opaque mass was being injected it could be seen to pass along the intercostal arteries of both sides thence to the graft, pericardium, and some into the circumflex branch, *A*, of the left coronary artery.

lateral. The former received its nourishment through the internal mammary artery and the latter through the intercostal artery. Having prepared the graft, the pericardium was opened, the epicardium and parietal pericardium roughened with a rasp, and the graft sutured with plain No. 00 catgut to the heart. The pericardial sack was left open. The chest wall was then closed over artificially inflated lungs.

The animal was again operated upon at 4 and 8 week intervals when branches of the right and left coronary arteries, respectively, were partially obliterated by silver clips.

Approximately 4 weeks after this interference with coronary circulation, the animal was sacrificed and the specimen was injected with a radio-opaque substance. We endeavored to isolate the heart in such a manner that

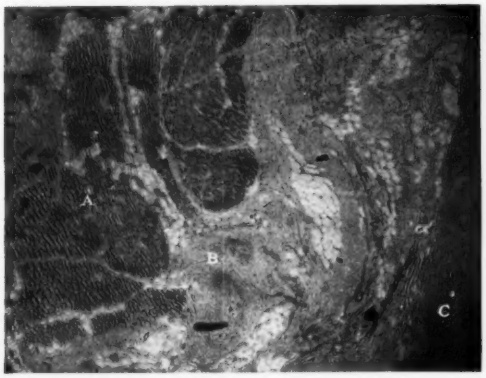

Fig. 5. The photomicrograph shows the fibrosis between the graft and the myocardium. *A*, skeletal muscle; *B*, area fibrosis; *C*, myocardium.

the injection mass could not enter the coronary circulation except by way of the graft (Figs. 3 and 4).

Bismuth oxychloride and acacia were injected into the cannulas as illustrated in Figure 2.

Graft of omentum to the heart. To illustrate this type of procedure the protocol of Dog 10 follows. The anesthesia used was the same as on previous experiments. The omentum was brought into the chest cavity through an opening in the left side of the diaphragm and sutured to the heart as were the muscle grafts. This operation was performed on September 20, 1939. On September 27, 1939, a silver clip was placed on the descending ramus of the left coronary artery. At frequent intervals electrocardiograms were made, as illustrated in Figure 6.

September 25, 1939. Normal sinus rhythm, rate 125. Prominent *Q*-wave in all leads and in leads II and III the *S*-wave are even more prominent. S-T_1 and S-T_3 are practically iso-electric. S-T_2 tends to slope downward; T_1 is flat; T_2 and T_3 are diphasic; *P-R*, 0.11; *QRS*, 0.07.

October 16, 1939. Ventricular tachycardia frequently interrupted by auricular and *A-V* nodal beats. The rate varies constantly but averages 220. In leads II and III the *QRS* complexes are slightly widened, somewhat bizarre in shape and notched at the peak. There is no demonstrable *S-T* segment as the downstroke of the sharply inverted *T*-wave is practically a continuation of the descending limb of the *R* complex. *QRS* equals 0.10.

October 27, 1939. Leads I and II only. Marked sinus arrhythmia, rate 65. P_1 iso-electric. P_2 con-

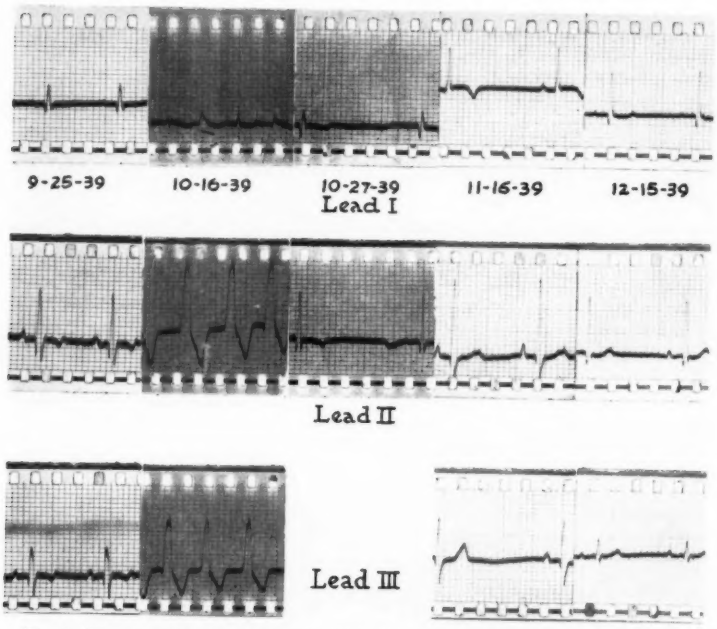

Fig. 6. Electrocardiograms in experiment, dog 10, omentum graft.

Fig. 7. Roentgenogram of an omentum heart graft injected specimen. *A*, omentum.

siderably lower than on September 26, 1939. Q_1 relatively more prominent than on previous tracings. Q_2 slightly less prominent and S_2 is definitely less prominent. S-T_1 depressed and tends to slope downward. S-T_2 depressed. T_1 is low and diphasic. T_2 is diphasic but chiefly inverted (similar to September 26, 1939). *P-R*, 0.11; *QRS*, 0.06.

November 16, 1939. Marked sinus arrhythmia, rate 95. Q_1 has disappeared. Small Q_2 and Q_3 present. S-T_1 very slightly elevated. T_1 has become

sharply inverted. T_2 remains upright and notched at the peak. T_3 increased in amplitude and sharply peaked. *P-R*, 0.10; *QRS*, 0.06. Characteristic of recent infarct.

December 15, 1939. Sinus arrhythmia, rate 95. *Q*-waves again present in all leads. S_2 and S_1 less prominent than on previous tracings. S-T_1 and S-T_2 slightly depressed and convex downward. S-T_3 slightly depressed. T_1 has turned upright but is of small amplitude. T_2 and T_3 have turned upright. *P-R*, 0.11; *QRS*, 0.06. Indicated marked improvement in coronary circulation. Residuals of previous infarction practically disappeared.

On December 18, 1939, the animal was anesthetized and bled to exsanguination through the left carotid artery. This specimen was examined carefully both before and after it was injected and cleared. First India ink and then red cinnabar (in water) were injected into the central stump of the left common carotid artery after the innominate artery, the left subclavian artery and the common iliac arteries were tied off.

There were firm adhesions of the omentum and parts of the pericardium to almost the entire ventral aspect of the ventricular portion of the heart. There were many blood vascular anastomotic connections between omental, pericardial, and myocardial vessels. These anastomoses were most numerous along the area normally supplied with blood along the branch of the left coronary artery and at the left basal region of the right ventricle. The anastomoses were large enough that the ink passed through the lumens of them but no evidence could be found that the cinnabar particles passed entirely through the lumens of any of them to reach the myocardial vessels. The clip on the left coronary artery was found near the base of the anterior branch of this artery. The clip had almost completely occluded this artery.

CONCLUSION

Our experiments tend to show:

1. The direct anastomosis of internal mammary artery to the coronary might be possible.

2. The omental graft lends itself best as a possible source of extracardiac blood supply to the myocardium. The graft remains pliable and the heart action is free.

3. Muscle grafts become quite firm, interfere with heart action and a layer of fibrosis develops between skeletal and myocardial muscles.

4. The heart of the healthy dog withstands diminution of its normal blood supply until it reaches the point of infarction and then recovers as demonstrated by the electrocardiogram.

5. Vascular connections between the graft and the heart muscle can be demonstrated in microscopic dissections.

Additional experiments are being carried out at the present time further to prove these contentions.

The writer wishes to acknowledge the assistance of Dr. Chester M. Kurtz who interrupted the electrocardiograms, Dr. P. F. Swindle who injected omental graft specimen and Dr. Elmer Franseen who gave much time and effort in the early phases of this work.

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PERICARDIECTOMY FOR CHRONIC CONSTRICTIVE PERICARDITIS

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THE fibrous tissue deposited in constrictive pericarditis results from a previous infection and produces symptoms as the constriction of the heart increases. The deposition of constrictive tissue may involve the pericardium or epicardium, but usually involves both in such a way that the two layers are adherent. Analysis of a large number of cases, reported in the literature, reveals the fact that about 20 per cent of them can be proved to be tuberculous in origin; the others are secondary to an infective process, of which the respiratory group, e.g. influenza, is important. It is agreed by most authorities making a study of the disease that rheumatic fever is not a primary factor. The disease has been popularized on the continent by Volhard and Schmieden, and in this country by Churchill, White, Beck, and others. The disease is readily confused with diseases such as congestive heart failure, hepatic cirrhosis, etc., even by trained cardiologists, as is suggested by the fact that it is being recognized and treated in a relatively small number of clinics. It is the chief purpose of this paper to attempt to point out the manifestations and laboratory procedures which will lead to a minimal amount of error in diagnosis.

CLINICAL MANIFESTATIONS

Perhaps the earliest symptoms complained of are weakness and dyspnea. The dyspnea, however, is usually noted only upon exertion, not being significant while the patient is resting or lying down. As soon as these symptoms develop, ascites and edema of the extremities are noted. Usually the ascites precedes the edema of the extremities by several weeks or months. Loss of weight generally occurs, but may not be appreciated by actual weight figures because of the development of ascites. Tachycardia, particularly upon exertion is fairly constant. Fever is absent. There may be a complaint of mild epigastric distress with anorexia. In the advanced stages of the disease slight anemia and a decrease in blood proteins, with a tendency toward reversal, will be noted.

Upon examination one of the most significant findings will be dilatation of the jugular veins, with or without pulsation. Heart sounds are faint, but rarely are murmurs present. A paradoxical pulse (thready in volume during inspiration) is fairly consistent. The blood pressure is low, and the pulse pressure diminished. In addition to ascites, fluid is usually encountered in the pleural cavity. It was this feature of the disease which Pick stressed when he originally reported observations on the syndrome. Rarely will Broadbent's sign be encountered, unless adhesive pericarditis is also present. Auricular fibrillation is occasionally encountered. Electrocardiograms usually reveal low voltage, inversion or flattening of the T waves in leads one or two, or both. In 2 or 3 patients, upon whom blood volume findings were made by Burwell and Blalock, the volume was found to be 30 to 45 per cent above normal. Cardiac output, however, is lower than average. Circulation time is delayed, varying between 30 and 60 seconds—normal, 15 to 20. Venous pressure is consistently high, ranging between 13 and 35 centimeters of water—normal is 5 to 10. The liver is enlarged particularly in the advanced cases, and as Harrington and Barnes have noted, liver function tests will show definite impairment of function. Upon examination, the heart shows no enlargement, and in fact, frequently is smaller than normal. There may be slight distortion of the lines of the cardiac shadow, in so far as some of the normal curves are straightened (Fig. 2a). About 20

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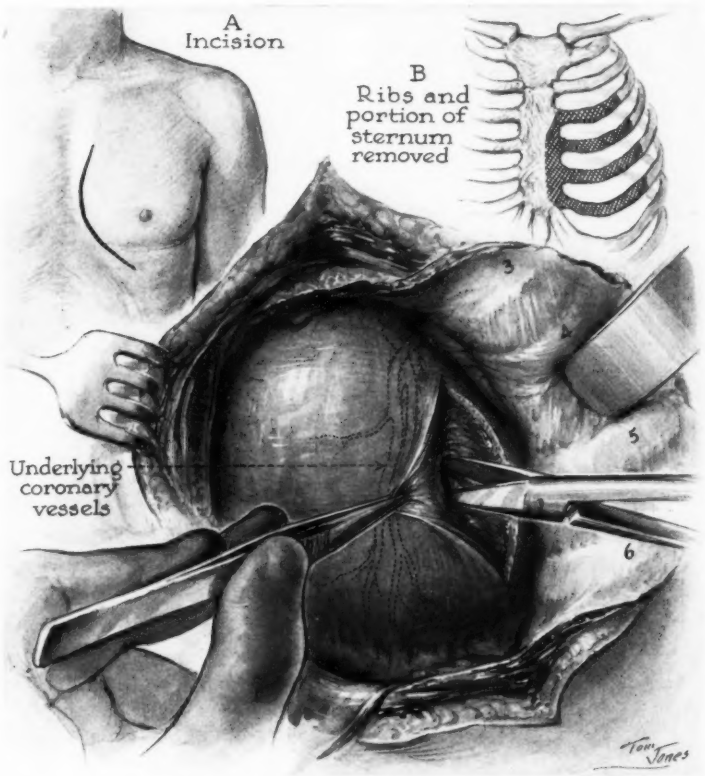

Fig. 1. Excision of the scar should be started over the left ventricle, and an attempt made to find a plane between the scar and cardiac muscle. All landmarks are usually obliterated, but the coronary vessels are illustrated by dotted lines to reveal their relative location. Injury to the coronary artery is dangerous but may be difficult to avoid, for occasionally it is buried in the scar. Insert A shows the type of incision; B, the area exposed and amount of sternum removed in the cases herein reported.

per cent of the patients with constrictive pericarditis have calcified plaques in the thickened pericardium and will be manifested in the x-ray film. Fluoroscopic examination usually reveals decrease in pulsation, particularly on the right side. This lack of pulsation will be best demonstrated by kymographic roentgenogram (Fig. 3a).

DIAGNOSIS

Perhaps the disease most readily confused with constrictive pericarditis is congestive heart failure. Valvular diseases will rarely be difficult to eliminate because of the presence of murmurs, which are absent in constrictive pericarditis. Although dyspnea is common in congestive heart disease, it is not diminished upon rest and lying down as markedly as it is in constrictive pericarditis. Of more importance also is the fact that ascites develops early in constrictive pericarditis, usually preceding the edema of the extremities, in contrast to its significance in congestive heart failure. Fluid is frequently found in the pleural cavities. The liver is usually enlarged. Of still greater importance in differentiation is the normal or slightly decreased shadow of the heart. With equal symptoms, the cardiac shadow in congestive heart failure will be enormously enlarged, whereas it is of normal

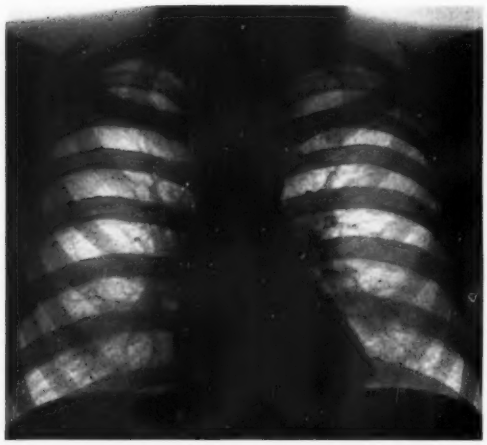

Fig. 2a. Roentgenogram of chest of patient in Case 1, before operation. Note the small heart and straight left border which was pulsating very little on fluoroscopy.

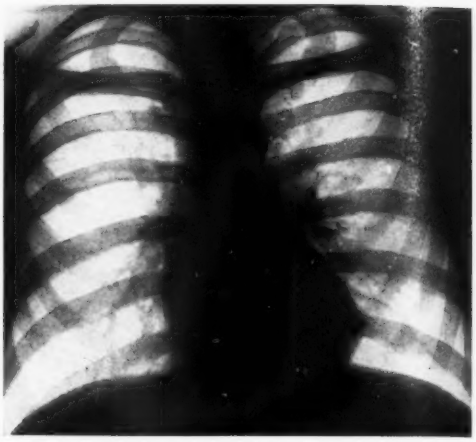

Fig. 2b. An x-ray picture taken 3 months after operation suggests that the heart has shifted upward but may still be fixed at a point on the left border.

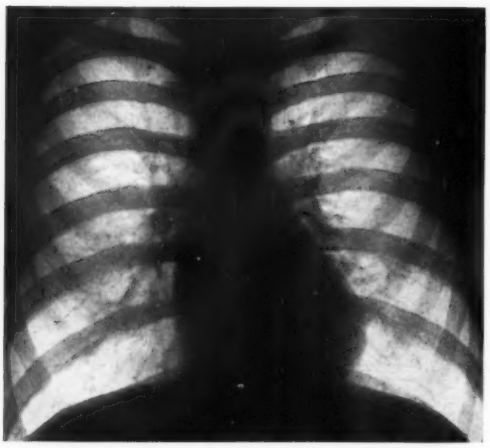

Fig. 2c. An x-ray picture taken 15 months after operation reveals normal shape with obliteration of the straight, fixed left border.

size or slightly smaller in constrictive pericarditis. Although distention of the jugular veins, elevation of the venous pressure, and delay in circulation time may be encountered in congestive heart failure, they are of diagnostic importance in constrictive pericarditis because of their frequency. The almost universal presence of a paradoxical pulse in constrictive pericarditis will be helpful in making the diagnosis. When calcification is present in the pericardium, the x-ray examination alone will make the diagnosis.

OPERATIVE CONSIDERATIONS

In 1902, Brauer suggested removal of the ribs and costal cartilages from the area over the heart. This operation was performed for constrictive pericarditis, and although a high incidence in improvement in symptoms was noted in a survey by Smith and Liggett, the operation is definitely inferior to actual removal of the constricting fibrous tissue. We are indebted to Delorme and Rehn for the development of the modern operation with removal of the constricting fibrous tissue.

Incision should be started slightly to the left of the sternum at the level of the second rib and curved toward the sternum and out laterally as the level of the sixth and seventh ribs is approached. Although local anesthesia may be used, it is the opinion of most men, including the present authors, making a study of the disease, that a general anesthetic is preferable. The fourth, fifth, and sixth costal cartilages and ribs are resected subperichondrially and subperiosteally. The intercostal muscles are cut away from the sternum, care being used not to devitalize any of the tissue, because it is of great importance in filling up dead space when the wound is closed. The

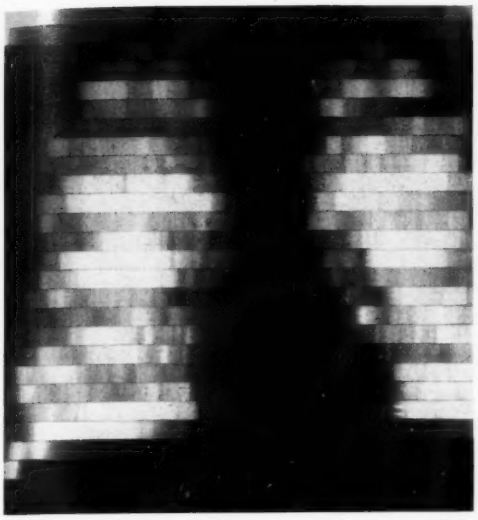

Fig. 3a. Roentgen-kymogram of Case 1, before operation. Note that pulsation is diminished on both borders of the cardiac shadow.

Fig. 3b. A roentgen-kymogram 3 months after operation reveals fairly pronounced and seemingly normal pulsation on each cardiac border.

internal mammary artery and vein should be ligated proximally and distally. Although some surgeons (Heuer) do not believe partial resection of the sternum is necessary, most, including the present authors, are in favor of removing the left half to facilitate exposure, particularly in excising the scar over the lateral surface of the right ventricle. The reflection of the left pleura is located and dissected outward along with adjacent tissue to allow exposure of the heart. As soon as the heart is exposed, attempt should be made to identify the descending branch of the left coronary artery and the auriculoventricular groove. Usually, however, all landmarks will be obliterated. Worse than this, as Burwell and Blalock have demonstrated, the descending coronary artery itself, is frequently imbedded in the scar, as it was in one of our cases, and may be injured during excision of the scar. Churchill is of the opinion that the scar should be carefully removed from the region of the auriculoventricular groove, but the authors wish to caution that this procedure must be done with extreme care because of the thinness of the auricular wall at the junction. Most authors, and we agree, do not believe it is necessary to remove the scar from the auricles, or the great vessels, unless the scar is markedly more pronounced here than elsewhere. The essential features consist of removal of the scar from the ventricles and from the apex. The apex is usually densely adherent to the diaphragmatic surface, and it is exceedingly important that this be freed. The excision of the scar over the ventricles should be started on the left side because of the danger of dilatation of the right ventricle if excision is started on the right side. Areas of calcification should be removed only if this can be done safely. Occasionally, the calcified plaque will extend deep into the ventricular wall. Removal might leave such a thin layer of muscle that perforation would develop.

Manipulation of the heart tends to produce arrhythmia. It is exceedingly important, therefore, that if the rhythm of the heart becomes disturbed, all operative manipulation should be terminated until normal rhythm is regained; restitution to a normal rhythm rarely requires more than a minute or two. During the process of excision of the scar a flap of fibrous tissue should be left attached to the heart so that it might be inserted firmly

against any bleeding point, whether it be perforation of the ventricle or incision through the descending branch of the left coronary artery. The importance of this precaution was appreciated in Case 1, reported herein, when a sudden, severe hemorrhage developed during excision of the scar over the left ventricle. Removal of the scar should be as complete as possible, but should not be extended laterally beyond the limits of good exposure because of danger of hemorrhage which could not be controlled with inadequate exposure. If the pleural cavity on either side is entered, the hole should be obliterated immediately and a suture taken to close it. Rarely will this jeopardize the patient's condition to any significant degree.

The dead space created by excision of the ribs is sealed up as well as possible with the pectoral and intercostal muscles. A small rubber drain should always be left in the inferior or superior part of the wound to prevent accumulation of fluid.

One of the most important considerations in postoperative care is oxygen therapy, which may be administered by a tent, mask, or nasal tube. Elevation of the back-rest of the bed will add to the comfort of the patient. Intravenous fluids should be given with caution because of the severe, sudden strain thrown on the heart incident to the operative procedure. The authors are of the opinion, however, that a small transfusion in addition to 500 to 700 cubic centimeters of glucose given slowly is safe and even advisable. Fluids and food are administered as tolerated. Digitalis may be used in the presence of fibrillation, but we do not favor its administration for tachycardia alone.

TABLE I.—VENOUS PRESSURE, CIRCULATING TIME, AND VITAL CAPACITY, CASE 1

	Venous pressure cm.	Circulating time (decholin) sec. 23.5	Vital capacity c.cm.
August, 1938	22	23.5	4600
September, 1938	26		
October, 1938	18.5	18.2	
November, 1938	20	17.4	5100
December, 1938	18.5	19	
January, 1939	16.5	20.2	
July, 1939	16.1	25	
September, 1939	12.5	21.7	5550
January, 1940	11.5	20	

(The pericardial resection was performed Oct. 12, 1938)

CASE 1. H. P., No. 62,292, a white laborer, 25 years of age, was admitted to the Illinois Research and Educational Hospital, August 29, 1938, complaining of abdominal swelling and weakness upon exertion. Eighteen months before admission he had an acute ailment with fever, generalized aching, pharyngitis, and albuminuria, followed in a few weeks by epigastric distress and a generalized edema. Progressive weakness was a major complaint. Abdominal paracentesis was performed several times during the last few months before admission to this hospital. At the time of admission to this hospital, abdominal distention—ascites—was sufficient to cause discomfort, but there was no orthopnea.

The temperature was normal, the pulse small and 85 to 95 per minute. The blood pressure was 116 systolic and 90 diastolic. No cervical veins were visible. The lungs were resonant and free from râles. The apex impulse was within the midclavicular line and there was slight retraction at the interspace during systole. The rhythm was regular. The liver was firm and not tender, it extended about 5 centimeters below the costal margin. The spleen was not palpable. The routine urinalysis, blood counts, and serology showed normal findings. The serum proteins were: albumin 3.0, globulin 3.45 grams per cent. Fluoroscopic examination demonstrated a restricted motion of the heart except at the apex. The 2 meter chest film showed a small heart, the right and left borders being straight, thus giving it a wedge shape. A roentgen-kymogram confirmed the fluoroscopic findings. The venous pressure was 22 centimeters, the decholin circulation time 23.5 seconds, and the ether time 12.6 seconds. Abdominal paracentesis yielded 6.5 liters of a straw colored fluid which contained 4.37 grams per cent of total protein; bacteriological examination—including guinea pig inoculation—was negative. The Mantoux test using 0.1 cubic centimeter of old tuberculin 1:100,000 gave a strongly positive reaction with a central necrosis. The electrocardiogram showed low QRS in the first lead and inverted T waves in the three standard leads. The T4 was low. A diagnosis of constrictive pericarditis was made.

Pericardial resection was performed October 12, 1938. The pericardium was adherent everywhere to the heart, but adhesions over the auricles were filmy and readily broken. No landmarks were visible because of the dense scar. The apex was attached to the diaphragm. In dissecting through this scar we opened into a cystic cavity containing about an ounce of brownish fluid with fibrinous material in it. The pericardium was so adherent to the heart muscle that it could be removed only by sharp

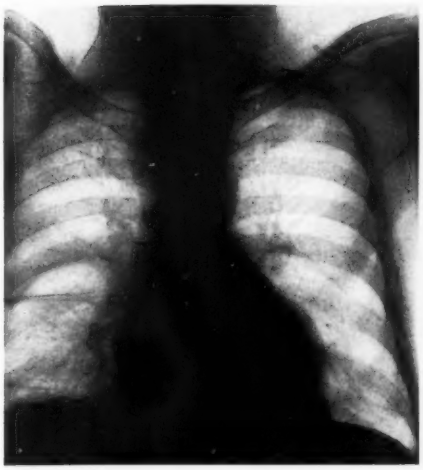

Fig. 4a. Roentgenogram of chest of the patient in Case 2. Note that the heart shadow is of a relatively normal size.

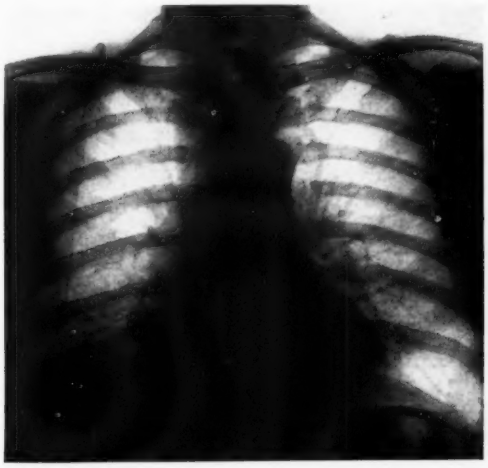

Fig. 4b. Case 3, no operation; few small cavities containing turbid fluid yielding tubercle bacilli on smear found within pericardial sac at autopsy.

dissection. During the process of cleaning the left ventricle a severe hemorrhage was encountered. A flap of fibrous tissue was rapidly inserted against this point, and two sutures were applied. This controlled the hemorrhage. We removed the scar as far laterally on each side as was deemed safe and freed the apex from the diaphragm. The wound was then closed; interrupted catgut was used and a drain was inserted at one point. The postoperative course was without complications except for a moderate rise in temperature—101 to 103°F.—and the development of a left pleural effusion. Thoracentesis 7 days after operation yielded 1200 cubic centimeters of fluid which contained a few polymorphonuclears, but no organisms were recovered. Later a thoracentesis was repeated. Abdominal paracentesis was never necessary after the operation. Roentgen-kymogram taken 2 months after the operation showed good movement of the ventricular borders. Chest films taken at intervals during the year following operation demonstrated a gradual development of a normal curvature of the ventricular borders and an increase in the heart size toward normal. Symptomatic improvement continued for at least a year after operation. This was demonstrated both in increased exercise tolerance and in a gradual drop in the venous pressure. Table I gives the values for venous pressure, circulation time, and vital capacity. An electrocardiogram taken 1½ years after operation showed better amplitude, but T_2 and T_3 still were deeply inverted. When last seen 2 years after operation he was working full time, and claimed that normal strength and physical reserve had returned.

CASE 2. E. G., No. 70,765, of Dutch descent, age 53 years, was admitted to Illinois Research Hospital, on February 29, 1940. His symptoms were first noted in September, 1936, at which time he complained of dyspnea on exertion. Soon he was unable to walk more than a block without marked fatigue and dyspnea; this was followed by edema of the ankles, but ascites did not develop until 2 months later. With bed rest the ankle edema subsided, but the ascites did not; he remained an invalid henceforth, being unable to be out of bed except for short intervals. Abdominal paracentesis was performed on several occasions by outside physicians before entry to the Illinois Research Hospital. His past history was not significant. He had not had rheumatic fever, nor any known tuberculous lesion.

On examination it was noted that there was no fever, the pulse was 90 and its volume became small with inspiration—paradoxical pulse. There was no dyspnea at bed rest but slight exertion caused marked dyspnea. There were cyanosis and a slight icteric tint. The abdomen was protuberant. The blood pressure was 104 systolic, 72 diastolic, when supine; standing it was 104 systolic and 84 diastolic. There were very prominent, distended, pulsating cervical veins. The veins over the lateral thorax and arms were also distended and prominent. Except for flaring of the costal margins and elevation of the diaphragm the lungs were normal. Cardiac dullness was found 2.0 centimeters to the right of the parasternal line and to the midclavicular line on the left. The apex beat could not be made out. The tones were normal but slightly decreased in intensity; there were no murmurs. Ascites was present, the liver was palpable three finger breadths below the costal margin, and it was firm and not tender. The spleen was not palpable. Moderate ankle edema was present. There was no clubbing of the nails.

The urine was normal, the blood contained 11.5 grams per cent hemoglobin; red blood cells, 4,400,000; white blood cells, 7,100. Wassermann and Kahn tests gave negative reactions. The serum albumin was 3.67, the globulin 4.69, the icterus index 11. The venous pressure at the antecubital vein was more than 30 centimeters. The decholin circulating time was 29 seconds, and the ether time 23 seconds. The vital capacity was 1600 cubic centimeters. After removal of 12.8 liters of ascitic fluid the vital capacity was 2600 cubic centimeters. The tuberculin test—0.10 c.cm. of old tuberculin 1:10,000—gave an area of redness and slight induration 4 centimeters across. The electrocardiogram showed the QRS waves to be low and slurred, and the T waves low and diphasic in the standard leads. The QRS 4 was slurred, T4 low and diphasic. The 2 meter chest film showed normal heart size, a straight right heart border, an unusual configuration of the left, and evidences of pleural fibrosis. Fluoroscopy showed limited movement. Roentgen-kymography showed decreased to absent movement of the right ventricle, good movement in the upper portion of the left ventricle, but restricted movement at the apex.

Pericardial resection was done on March 27, 1940. Exposure of the heart revealed all landmarks gone. The auricles were enormously distended. The ventricles were squeezed down to a mass not much larger than a lemon by the dense scar tissue. The excision of the thickened pericardium was started over an area which appeared to be the left ventricle. Further dissection of scar tissue was carried to the lateral border on each side. The cardiac muscle was so cyanotic and appeared so friable that we were much discouraged as to the outcome. Neither did the heart bulge out through the opening in the scar tissue as much as we expected. The wound was closed with silk, without drainage. Accumulation of fluid the following day made it necessary for us to insert a drain between some sutures.

Patient was sent to the ward and given oxygen therapy. Condition remained unchanged for several days, but 2½ weeks after operation, he developed increased signs of cardiac decompensation, and died 2 days later with exacerbation of his symptoms.

Case 3. B. W., No. 68,529, a male aged 64 years, was admitted to the Illinois Research and Educational Hospital, September 27, 1939. He had been comparatively well until May, 1939, when he noticed fatigue and weakness, associated with a cough, which was occasionally productive of a tenacious yellow sputum. Anorexia became marked and he rapidly lost 45 pounds in weight. In June he developed dyspnea, ascites, and edema of the legs. With increasing ascites he developed pain in the upper abdomen. The blood pressure was 112 systolic and 90 diastolic; the pulse 90, and the temperature normal. There was a pleural effusion on the right and crepitant râles at the left base posteriorly. The heart borders were found within normal limits. There were no murmurs. Moderate ascites was present. A mass believed to be the liver extended to the umbilicus, it was firm and tender. Pitting edema was present at the ankles. Roentgen examination of the chest after thoracentesis showed evidences of pulmonary congestion and some fluid in the right pleural space. The transverse thoracic diameter was 30.6 centimeters and the largest transverse cardiac diameter was 14.5 centimeters. The specific gravity of the pleural fluid was 1.011; the protein content 1.46 grams per cent. Smears were negative. The culture of the pleural fluid was negative; guinea pig inoculation was negative. The tuberculin test using 0.1 c.cm. of 1:10,000 old tuberculin intracutaneously was positive. The venous pressure taken on October 12, 1939 gave a value of 30 centimeters. Decholin circulation time was 22.4 seconds; the ether time was 4.6 seconds. Urinalysis showed a trace of albumin and occasional pus cell. The hemoglobin was 16.5 grams per cent; the red blood cells, 5,200,000; white blood cells, 6,750. The Wassermann and Kahn tests were negative. The serum albumin was 3.6 per cent and the globulin 2.8 per cent. The icterus index was normal. The electrocardiogram showed low QRS complexes and low diphasic T waves in the standard leads.

Because of the patient's age, the pulmonary congestion, and failure of fluoroscopic examination to reveal restriction of cardiac movements, a diagnosis of cardiac decompensation due to myocardial insufficiency secondary to arteriosclerosis was accepted in preference to constrictive pericarditis.

Decompensation progressed. Repeated thoracentesis and abdominal paracentesis were necessary. In the course of the disease a painful mass developed in the right lower quadrant. Death occurred on February 12, 1940.

Autopsy showed a firm cartilaginous pericardium reaching a thickness of 10 millimeters and inseparably fused to the epicardium. The scarred pericardium contained several small collections of milky fluid. Smears of this fluid showed numerous acid fast organisms which on culture were found to be tubercle bacilli. The outer surface of the pericardium was smooth. The coronary arteries were patent throughout but contained an occasional atheromatous deposit. There was also a tuberculous peritonitis with the omentum formed into a thick mass across the upper abdomen. The mass in the right lower quadrant was composed of several adherent loops of bowel. There was a miliary tuberculosis of the liver, kidney, spleen, adrenals, retroperitoneal nodes, and lungs. From the autopsy findings it was evident that the tuberculous pericarditis was of much longer duration than the tuberculous peritonitis.

IMPORTANT POINTS IN DIAGNOSIS AND TREATMENT

Beck has stressed the physiological concept that the heart in constrictive pericarditis is a heart under compression. It is a small one

imprisoned by the constricting adhesions. Its embarrassment is caused by an inability to hold in diastole sufficient blood to maintain an adequate arterial circulation. Hence the cardiac output (Heuer and Stewart) of necessity falls and under exertion the heart rate increases as a compensatory adjustment. When the output falls excessively, there is a discrepancy between the blood volume and the vascular bed. The vasomotor center becomes unable to reduce the arterial bed correspondingly and the blood pressure falls. The circulation is inadequate and it can be readily appreciated that these patients will first complain of indefinite symptoms, as easy fatigability, slight dyspnea after exertion, and later, more and more serious limitation of activity. When they are examined at this stage the heart borders are normal both on physical and fluoroscopic examination. Usually no murmurs are heard, and the circulatory inadequacy is attributed to myocardial weakness with a loss of cardiac reserve. The patient is considered to have a decompensation which produces symptoms but, as yet, no signs.

As the condition progresses and the compression becomes more severe, the blood piles up in the vena cava, and gradually backs into the finer systemic venous radicles. The venous pressure in the vena cava which normally is negative, becomes positive, and continues to rise until it exceeds the limiting pressure exerted on the relaxing auricle. When it is in excess of the intrapericardial pressure the blood flows in to fill the auricles. The height of the venous pressure gives one an index of the severity of the cardiac compression. The anticubital venous pressures in the 3 cases were, respectively, 26, 30, and 30 cubic centimeters of salt solution. With the increasing venous pressure the blood accumulates in the first available reservoir. All the systemic veins have valves and these combined with the pumping effects of muscular action tend to keep the blood flowing towards the heart. The hepatic veins are without valves and the liver is readily distensible so it first receives the extra blood. The liver then becomes congested, large, tender, and establishes a portal decompensation. With long continued congestion liver damage occurs, producing varying pathological pictures, ranging from fatty livers through fibrosis to cirrhosis. It is interesting that the spleen is not usually palpable. When the patient is seen at this stage of the disease he presents a normal sized heart without murmurs, prominent veins, ascites, and a large liver. After paracentesis, the spleen is still not palpable. A plate of the chest shows no evidence of pulmonary congestion. The abdominal findings are so striking that the distention of the veins, unless marked, is overlooked. Even if the patient complains of dyspnea this also is easily attributed to a lowering of the vital capacity by upward pressure from the distended abdomen. Hence the ascites now stands out as the prominent symptom demanding explanation. If the patient is middle aged, the diagnosis of cirrhosis becomes probable. The liver function tests, however, do not indicate as much damage as would be expected in a frank cirrhosis. The spleen also is not palpable. Hence, carcinomatosis with fluid formation and tuberculous peritonitis will be considered. The ascitic fluid will have a lower protein content than would be expected in these conditions and the clinical course will have been too protracted to render the diagnosis of carcinomatosis tenable. A tuberculous peritonitis is eliminated with much more difficulty. In fact, it existed in Case 3 along with a tuberculous pericarditis. At this point the patient is re-examined carefully. The prominent veins are again noted, a venous pressure reading is taken. This is increased and rises still higher when pressure is exerted over the liver. The correct diagnosis is now possible, and should be made.

As the condition progresses there is added to the picture a generalized edema beginning in the feet extending later to the arms, face, and body. This represents a more advanced stage of venous stasis. The blood volume will be increased. The circulation time will be prolonged. Since these findings are present in all cases of congestive heart failure, the significance of an increased venous pressure is lost. The diagnosis still should be made at this stage. Cardiac decompensation does exist. The point at issue is the cause of the decompensation. If the patient had a rheu-

matic valvulitis or arteriosclerotic heart disease with myocardial damage, one would expect to find a heart somewhat larger than normal and a lung which shows passive congestion. This passive congestion would be revealed by transitory attacks of blood tinged expectoration and by an x-ray plate revealing pulmonary congestion. In constrictive pericarditis the blood does not get into the heart and the quantity which does get into the auricle is readily pumped into the arterial circulation. There is therefore, no opportunity for blood to accumulate in the lung. On the other hand, a clear lung is not compatible with a diagnosis of congestive heart failure, left ventricular failure or a rheumatic valvulitis.

When a pleural effusion appears the diagnosis becomes increasingly difficult. One now has the complete picture of congestive failure. The pleural effusion is still to be attributed to systemic venous congestion of the parietal pleura. However, it encroaches on the lung to such an extent that evidences of pulmonary congestion appear secondarily. The history of the appearance of ascites prior to the frank decompensation, and the findings of a small heart without murmurs should point to the proper diagnosis. A cardiac cirrhosis also can be eliminated by the absence of a mitral stenosis.

If the compression of the heart is produced by a combination of constrictive adhesions and fluid, then the heart size will be increased. This will add to the diagnostic difficulties, but it will not make them insuperable.

In 1 of the cases herein reported the constrictive pericarditis was definitely secondary to tuberculosis. In the 2 others, both of which were operated upon, a strongly positive tuberculin test was obtained. However, microscopical examination of the scar tissue revealed no evidence of tuberculosis.

Of the 2 patients operated upon, 1 died. He survived the operation, but showed only mild improvement, and died several weeks later with symptoms typical of cardiac failure. Unfortunately, autopsy was not obtained. This patient was 53 years old and had had severe symptoms for about 4 years. In going over the patients reported in the literature, the poor results, particularly as related to mortality, were much more common in elderly patients. In fact, very few who were operated upon were as old as this patient. It seems obvious that considerable irreparable myocardial damage existed in this patient. As a matter of fact, the heart muscle as uncovered by excision of the scar was so cyanotic and friable that we considered it almost necrotic and feared spontaneous perforation. Heart muscle which was as unhealthy as this obviously could not regain much of its original function. We are, therefore, strongly of the opinion that the mortality rate will be much lower in young people whose cardiac muscle is more apt to be reasonably well preserved. It is even possible that patients past the age of 50 should be operated upon only if they appear to be reasonably good operative risks.

Observations on vital capacity might be important in determining prognoses as far as fatality following operation is concerned. For example, the vital capacity of patient in Case 2, who died several weeks after operation was 1600 before abdominal paracentesis, and 2600 after paracentesis, contrasted to a vital capacity of 4600 in Case 1, in which recovery following operation was satisfactory.

The authors wish to emphasize particularly that recovery may take place for at least a year following operation. For example, in Case 1 patient showed improvement for at least a year following the date of operation. In fact, at the end of 1 year his strength had not completely returned to normal although he was relatively free from symptoms. When last seen, which was almost exactly 2 years after operation, he stated that his strength had entirely returned, that he was free from symptoms, and working daily running a press.

SUMMARY

Undoubtedly, innumerable cases of constrictive pericarditis are erroneously diagnosed as congestive heart failure, hepatic cirrhosis, etc., because of the similarity of symptoms to those of constrictive pericarditis. It is particularly important that this error be avoided because sufficient operative reports are now available to establish the fact that although

the mortality rate is high, the results otherwise are excellent. Perhaps the first symptom of constrictive pericarditis is weakness, followed soon by dyspnea upon exertion. Of great diagnostic significance is the fact that in this disease the dyspnea is not present while the patient is inactive and that ascites precedes edema of the extremities. Distended neck veins, high venous pressure, paradoxical pulse, and small cardiac shadow constitute important evidence for the diagnosis.

Since conservative treatment of the disease is hopeless, operation should be performed early, before myocardial damage due to compression, etc., is irreparable. Results are much better in young people; very few patients in late adult life survive the operation. Results may not be immediate, as emphasized by the fact that in one of our patients strength was still subnormal 1 year following operation, but 2 years after operation he felt perfectly normal and was working daily running a press.

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EXTENSIVE CUTANEOUS BURNS

With Special Reference to the Blood Chemical Changes

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THE historical background of burns has been adequately covered in many previous publications and need not be repeated; however, one quotation from the older literature seems pertinent:

"From the very great variety of applications so strongly recommended by the first characters, an unbiased individual would be at a loss on what to determine. . . . I presume one of the great causes of error is the assigning to various applications the cure of slight burns, some of which no doubt would have got well without any, and perhaps much sooner than with those which were used. . . . This mistake frequently happens from good motives, and by the best intentioned people; for if we have seen a person recover from any complaint during the use of any particular means, we naturally imagine such beneficial effect to have arisen from that cause, although, upon further investigation, it may be found to have been inadequate."

Thus, in 1797 Edward Kentish expressed his opinion of the contemporary investigation and treatment of burns. In the past 20 years many different local applications have been recommended; likewise, many theories have been presented to explain the cause of the systemic manifestations seen in burned patients.

No attempt has been made in this study to evaluate the various local applications. The feeling in this clinic has been that cleanliness is the most important factor in the local care of the burned area. The patients to be presented in this study were given adequate doses of morphine on admission; then, when comfortable and, if the general condition permitted, the burned areas were washed with gauze sponges, soap, and water, while débridement was carried out at the same time. Most burns except those of the face and hands were covered with either a tannic acid silver nitrate (3) eschar or a gentian violet silver nitrate (5) eschar. Blair jelly was applied to burns of the face and hands immediately after cleaning, and, after 48 hours, continuous saline soaks were applied.

Underhill and his associates (27) have shown that immediately after severe burns primary shock may develop as the result of pain and fright; they also stressed the importance of hemoconcentration resulting from plasma loss into the burned area, mainly during the first 24 hours (22, 23, 24, 26, 27). Aldrich has emphasized the rôle that absorption of bacterial toxins from an infected burned area may play in producing systemic changes. The time relationship between these three factors may be diagrammatically represented as shown in Figure 1. With adequate therapy these factors may be prevented or controlled; but even so, the burned patient may still develop a syndrome characterized by lowered blood pressure, tachycardia, hyperpyrexia, anorexia, malaise, increasing lassitude, and later, in severe cases, delirium, coma, and death. This condition, which usually makes its appearance 24 to 72 hours after the burn, is usually referred to as the toxemia of burns, or more preferable—the toxic stage of burns. The etiology of this syndrome has been the subject of much study and discussion, and the recent trend of interest in this respect has been in the field of blood electrolytes.

Underhill in 1923 (24) pointed out a decrease in serum chlorides following severe burns. In 1926 Davidson (7) confirmed this and made a note of a chloride retention which he concluded must lie in the tissues. One year later Davidson (8) reported a study of serum proteins in which he found a slight decrease over a period of days after the burn, though frequently an increase was noted in the presence of hemoconcentration. Weiner, Rowlette, and Elman, in 1936, emphasized the fact that large amounts of parenteral saline solution frequently carries the serum protein to an

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edema level. All of these findings have since been confirmed by several groups of investigators (9, 14, 25); however, very few studies have been made on the effect of severe burns on potassium. Wilson (32) found a consistent, marked decrease in the serum sodium level corresponding with the general condition of the patient; treatment with desoxycorticosterone acetate tended to elevate the serum sodium with a coincident clinical improvement in the patient. Wilson also noted elevations of the serum potassium. Scudder (19) has presented a study of plasma potassium in 6 cases of severe burn in which he found elevations similar to those he had found in other forms of shock; he employed eschatin[1] in the treatment of these cases. Keeley, Gibson, and Pijoan carried out blood electrolyte studies on 7 dogs after experimental burning but found no increase in the serum potassium. This finding may possibly be explained on the fact that the potassium in the dog's red cells is very nearly the same as in the serum; thus, less potassium would be liberated after cell damage and intravascular hemolysis.

If one considers the known pathological physiology which follows severe burns, an elevation of plasma potassium would be predicted for several reasons: (a) the tissue autolysis, which follows death of cells after burning, necessarily sets free the intracellular potassium; (b) hemolysis of the red cells within the vessels of the burned area likewise liberates potassium; (c) in the presence of a lowered blood pressure renal excretion is diminished, thus hindering the elimination of excess potassium; (d) the renal damage which occasionally follows severe burns would have a similar effect; (e) liver damage frequently occurs, and this may interfere with the hepatic storage of excess potassium; and finally, (f) adrenal degeneration, infarction, and hemorrhage have all been described as occasional findings at autopsy, and in such cases sodium and potassium metabolism would certainly be effected.

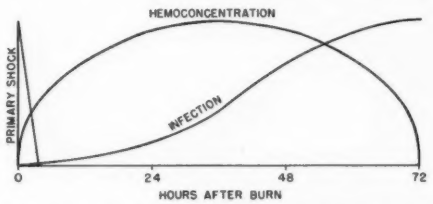


Fig. 1. Showing the chronological relationship between primary shock, hemoconcentration, and systemic manifestations of infection (Modified from Gunn and Hillsman).

It is the purpose of this study to evaluate the rôle of blood electrolyte changes, especially potassium, in the production of the symptoms of the toxic stage of burns.

METHOD OF STUDY

Eight cases of severe burn entering the Detroit Receiving Hospital were selected for study. There were 2 females and 6 males in this group, and the ages ranged from 8 to 51 years. The causes of injury were house fire, clothing on fire, and gas explosion. The

[1]Eschatin—adrenal cortical hormone, manufactured by Parke, Davis, and Company.

TABLE I.—POSTMORTEM FINDINGS IN THE 3 FATAL CASES STUDIED

	F. B.	G. B.	C. R.
Lungs	Extensive bronchopneumonia. Evidence of chronic congestion	Severe hyperemia	Moderate hyperemia
Heart	Normal	Normal	Coronary arteriosclerosis Grade I. Normal myocardium
Gastro-intestinal tract	Normal	Mild terminal diffuse hemorrhagic gastritis	Normal
Liver	Occasional areas of mild focal necrosis. Grade I cirrhosis	Mild parenchymatous degeneration	Occasional very small areas of mild focal necrosis
Kidneys	Normal	Moderate hyperemia	Moderate hyperemia. Mild toxic nephrosis
Spleen	Splenomegaly (970 gms.) Primary splenic fibrosis	Severe hyperemia with small areas of hemorrhage	Moderate hyperemia
Adrenal glands	Very occasional areas of focal necrosis	Enlarged (3 times) Cloudy swelling of cortical cells	Normal

HOURS AFTER	1	14	45	62	87	110	135
HEMATOCRIT	53.0	74.0	58.5	51.5	43.0	43.5	44.5
W.B. POTASSIUM	220	285	223	193	164	168	174
CELL POTASSIUM	401	379	368	357	363	368	376
PL. POTASSIUM	15.4	17.7	18.2	16.9	14.9	14.0	12.8
PL. PROTEIN	5.77	6.29	5.21	5.16	4.17	4.56	4.74
PL. SODIUM	145	139	129	123	126	127	133
PL. CHLORIDE	102	103	100	99	94	97	98
PL. VITAMIN C	—	—	.04	.08	—	.14	—
PL. N.P.N.	—	—	—	31.6	—	—	24.8
PULSE / TEMP.		BURNED					DIED
PARENTERAL FLUID: PLASMA; 5%G. in SALINE (Liters)							
DATE	10/5	10/6	10/7	10/8	10/9	10/10	10/11

Table II.—F.B., white, ♂, aged 47, 25 per cent of body burned in gas explosion.

depth of burn in each case was diagnosed as first, second, third, and fourth degree burns (Dupuytren's classification, 15); the smallest total area involved was 15 per cent and the largest 50 per cent of the total surface area of the body (Berkow scale).

Blood pressure studies could not be carried out on any of these cases as all of them were burned over both upper extremities. Evidence that the toxic stage was present is based purely upon clinical judgment with the aid of the temperature and pulse charts. L. T. and O. C. showed no definite toxic symptoms. M. P., B. L., and W. P. showed moderate reactions but at no time were in shock. These 5 patients recovered. Unquestionable, severe symptoms of the toxic stage were present from the second 24 hour period after burning until

HOURS AFTER	2	14	40	66	115
HEMATOCRIT	46.5	48.5	45.0	42.5	40.5
W.B. POTASSIUM	181	199	177	172	173
CELL POTASSIUM	372	394	376	386	402
PL. POTASSIUM	15.0	14.9	15.1	14.7	16.7
PL. PROTEIN	7.85	6.26	5.96	5.87	6.54
PL. SODIUM	143	141	139	139	143
PL. CHLORIDE	116	109	107	104	107
PULSE / TEMP.		BURNED			RECOVERED
PARENTERAL FLUID: 5%G. in SALINE (Liters)					
DATE	6/1	6/2	6/3	6/4	6/5	6/6

Table III.—L.T., white, ♀, aged 25, 15 per cent of body burned. Clothes on fire.

HOURS AFTER	2	29	51	76	124
HEMATOCRIT	44.5	51.0	51.0	41.5	44.5
W.B. POTASSIUM	183	234	202	173	186
CELL POTASSIUM	396	439	378	400	400
PL. POTASSIUM	13.5	19.7	17.7	12.0	15.0
PL. PROTEIN	6.56	7.04	6.40	6.11	6.75
PL. SODIUM	144	137	141	140	137
PL. CHLORIDE	106	102	104	104	98
PULSE 140 130 120 110 100 90 80 / TEMP. 104 103 102 101 100 99 98					
PARENTERAL FLUID 2 / PLASMA / WHOLE BLOOD 1 / 5%G. in SALINE Liters					
DATE	4/7	4/8	4/9	4/10	4/11	4/12

Table IV.—B.L., white, ♂, aged 11 years, 20 per cent of body burned. Clothes on fire.

death in Cases F. B., G. B., and C. R. At autopsy F. B. showed an extensive bronchopneumonia, probably as the result of inhaling hot fumes; however toxic symptoms were present for at least 3 days before the pneumonia developed. In Cases G. B. and C. R. no definite pathological cause of death could be found at autopsy. Table I shows the postmortem findings in these 3 fatal cases.

Parenteral plasma, whole blood, glucose, and saline were given each patient as indicated. It is granted on retrospect that the treatment was not ideal in all cases; but it was sufficient to prevent primary shock, to control hemoconcentration, and to keep infection to a minimum.

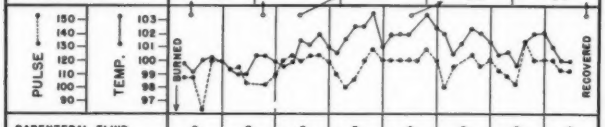
All blood samples were taken at an interval when no parenteral fluid was being administered. Ten cubic-centimeters of venous blood were drawn into a clean syringe and carefully transferred to a tube containing 2 milligrams of dry purified heparin. The tube was then tipped four or five times in such manner that the heparin dissolved without causing foaming of the blood. Two cubic centimeters of blood were then immediately poured into another tube for hematocrit and whole blood potassium determinations, and the remainder of the blood was centrifuged without delay.

This extreme care and speed is necessary because of the great error in potassium determinations which can result from diffusion of potassium from cells to plasma or by liberation of cellular potassium through hemolysis. Heparinized plasma was chosen in preference to serum because a greater interface exists between clot and serum than between centrifuged cells and plasma—thus allowing a greater area for diffusion. No blood was taken

HOURS AFTER	2	28	52	99
HEMATOCRIT	43.0	49.0	46.5	40.0
W.B. POTASSIUM	178	197	193	169
CELL POTASSIUM	395	384	394	398
PL. POTASSIUM	14.8	17.1	19.0	16.7
PL. PROTEIN	7.55	6.48	6.67	6.75
PL. SODIUM	143	132	132	132
PL. CHLORIDE	102	104	100	97
PULSE 120 110 100 90 80 70 / TEMP. 103 102 101 100 99 98				
PARENTERAL FLUID 2 / 5%G. in SALINE Liters				
DATE	4/6	4/7	4/8	4/9	4/10

Table V.—O.C., negro, ♂, aged 51, 20 per cent of body burned. Clothes on fire.

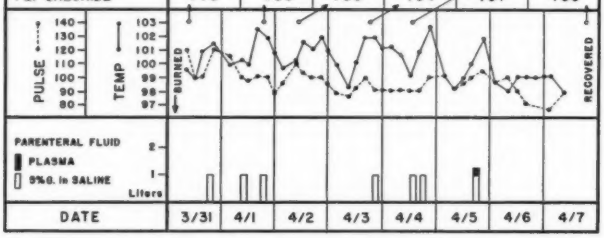
HOURS AFTER	6	36	54	105	180
HEMATOCRIT	51.0	52.0	46.0	38.5	38.0
W.B. POTASSIUM	207	198	188	156	154
CELL POTASSIUM	406	-	387	408	379
PL. POTASSIUM	16.6	-	18.2	14.1	15.6
PL. PROTEIN	6.79	-	6.60	6.50	6.41
PL. SODIUM	140	-	139	129	133
PL. CHLORIDE	108	-	-	95	97



PARENTERAL FLUID	0	0	0	0	0	0	0	0
DATE	3/31	4/1	4/2	4/3	4/4	4/5	4/6	4/7

Table VI.—M.P., white, ♀, aged 8, 20 per cent of body burned. House fire.

HOURS AFTER	5	36	54	84	105	180
HEMATOCRIT	55.0	52.0	49.0	46.5	45.5	50.0
W.B. POTASSIUM	216	190	193	183	176	203
CELL POTASSIUM	380	350	378	376	371	390
PL. POTASSIUM	16.4	16.3	16.6	14.5	13.5	15.3
PL. PROTEIN	6.93	5.45	5.46	5.98	6.11	8.46
PL. SODIUM	145	133	136	135	136	139
PL. CHLORIDE	110	106	106	104	101	109



DATE	3/31	4/1	4/2	4/3	4/4	4/5	4/6	4/7

Table VII.—W.P., white, ♂, aged 22, 25 per cent of body burned. House fire.

after death in Cases F. B., G.B., and C. R. because of the immediate postmortem rise in potassium which Scudder (20) has demonstrated.

The hematocrit was determined by centrifuging for 20 minutes at 2,000 revolutions per minute in Van Allen hematocrit tubes (28), and the micro-Kjeldahl method (16) was used for the estimation of plasma protein. Potassium was determined on plasma and whole blood by the photo-electric chloroplatinic acid method of Tenery and Anderson. Cell potassium was calculated by the formula:

$$\text{Cell potassium} = \left(\text{whole blood K} - \text{plasma K} \times \frac{(100 - \text{hematocrit})}{100}\right) \times \frac{100}{\text{hematocrit}}$$

The method of Hoffman and Osgood was used for plasma sodium, and plasma chlorides were determined by the method of Wilson and Ball (30).

HOURS AFTER	3	14	112	182
HEMATOCRIT	55.5	68.5	46.0	34.5
W.B. POTASSIUM	232	274	-	166
CELL POTASSIUM	405	390	-	455
PL. POTASSIUM	15.4	23.6	-	14.3
PL. PROTEIN	6.25	6.05	5.98	5.41
PL. SODIUM	148	141	-	163
PL. CHLORIDE	103	104	-	130

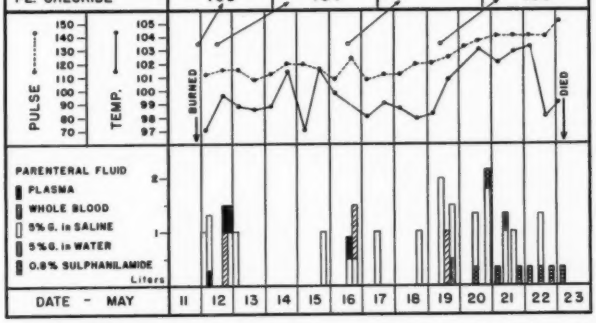


Table VIII.—C.R., white, ♂, aged 35, 40 per cent of body burned. Gas explosion.

HOURS AFTER	5	54	83	124	151	179	203
HEMATOCRIT	61.0	44.0	41.0	46.5	41.0	43.0	43.0
W.B. POTASSIUM	230	178	149	175	173	192	222
CELL POTASSIUM	368	382	342	359	395	428	-
PL. POTASSIUM	14.4	17.4	15.4	15.2	15.7	14.3	-
PL. PROTEIN	6.05	4.33	4.88	6.17	6.10	6.29	-
PL. SODIUM	145	129	131	141	145	163	-
PL. CHLORIDE	110	99	106	95	108	129	-
ESCHATIN-c. cm.	-	-	-	-	20	10	10	-	-	-

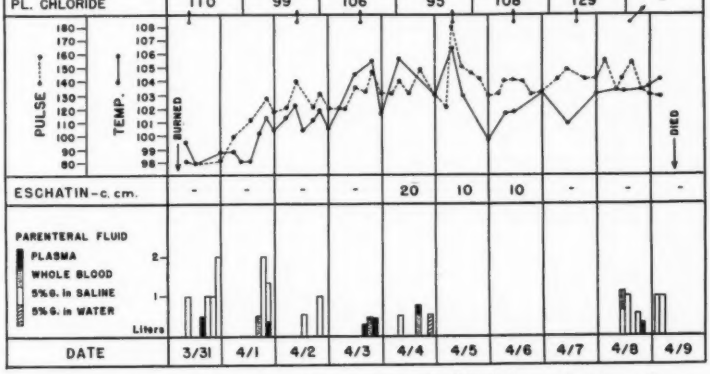


Table IX.—G.B., white, ♂, aged 26, 50 per cent of body burned. House fire.

We have found an average normal range for each of these determinations to be: hematocrit, 40 to 45 per cent cells; plasma potassium, 14 to 18 milligrams per 100 cubic centimeters; whole blood potassium, 150 to 200 milligrams per 100 cubic centimeters—depends on hema-

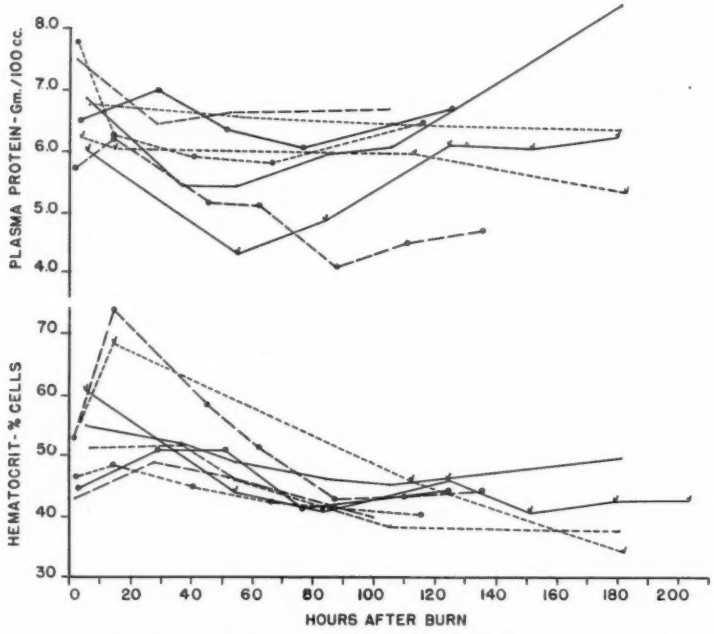


Fig. 2. Composite graph of plasma proteins and hematocrit on the 8 patients studied.

Key to Figs. 2, 3, 4.

F.B.—W ♂ 47—25% body burned.
L.T.—W ♀ 25—15% body burned.
B.L.—W ♂ 11—20% body burned.
O.C.—B ♂ 51—20% body burned.
M.P.—W ♀ 8—20% body burned.
W.P.—W ♂ 22—25% body burned.
C.R.—W ♂ 35—40% body burned.
G.B.—W ♂ 26—50% body burned.

tocrit; cell potassium, probably 375 to 425 milligrams per 100 cubic centimeters; plasma sodium, 140 to 150 milli-equivalents per liter; plasma chloride, 98 to 110 milli-equivalents per liter; plasma protein, 6.5 to 7.5 grams per 100 cubic centimeters.

FINDINGS

The results of these various procedures on the 8 patients studied are presented in Tables II to IX. The time relationships between the temperature, pulse, parenteral fluid, and blood chemical determinations are shown; the small arrows at the top of each temperature chart indicate the time at which each blood sample was taken. Hematocrit is expressed as per cent of cells, potassium as milligrams per 100 cubic centimeters, and sodium and chloride as milli-equivalents per liter. Figures 2 3, and 4 are composite graphs of the cases studied.

In all of these patients the hematocrit rose (Fig. 2), but only in C. R., G. B., and F. B. did it reach a very high level before adequate therapy brought about dilution. It was of great interest to note the relatively high readings of the first sample from each case, though taken only a short time after burning. F. B. had a hematocrit of 53 per cent only 1 hour after receiving burns of 25 per cent of the body. In a patient, whose case is not reported in this series, who had burns over 100 per cent of the body surface, we found a reading of 71 per cent in venous blood 1 hour after burning; this would indicate that about one-half of the total plasma volume had been lost

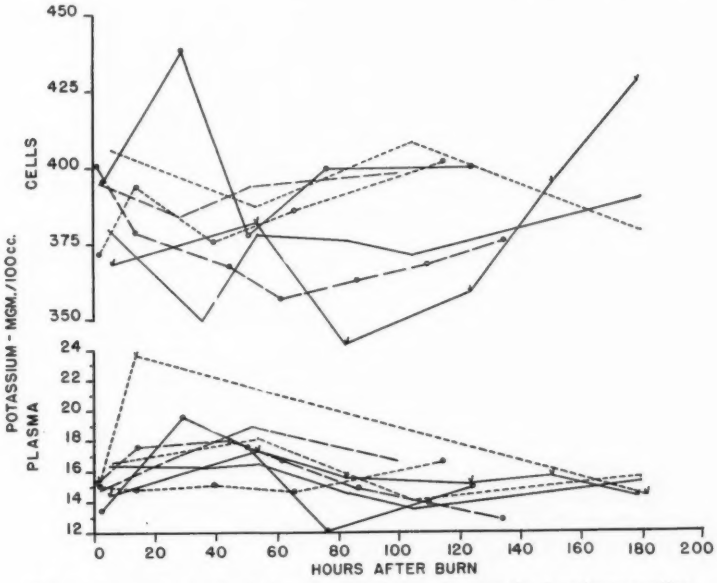


Fig. 3. Composite graph of plasma and cell potassium on the 8 patients studied.

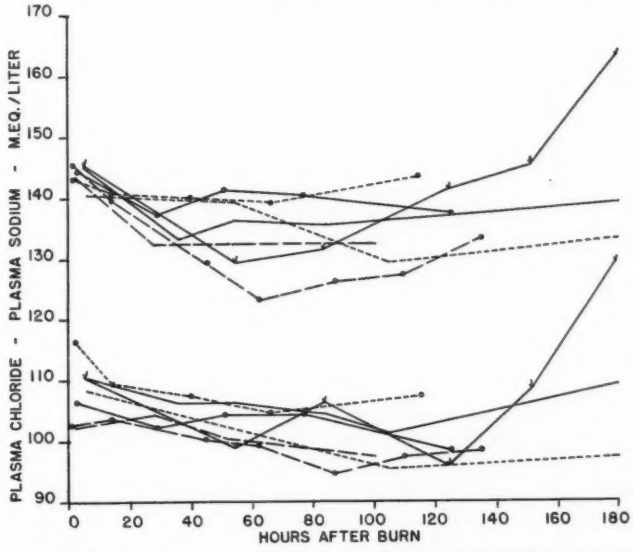


Fig. 4. Composite graph of plasma sodium and chloride on the 8 patients studied.

in that short time. In general, we have found that about one-half of the hemoconcentration that is to occur was present 6 hours after the burn. This indicates the need for plasma transfusion as early as possible as hemoconcentration is easier to prevent than relieve.

The plasma protein levels (Fig. 2) in these cases are similar to those previously reported. G. B. was given large amounts of saline and relatively little plasma in the first 54 hours after injury with a resultant marked drop in plasma protein accompanied by clinical edema. M. P. was given no parenteral saline and consequently had only a gradual slight lowering of the protein. The findings in all cases indicate the need for conservatism in the use of parenteral saline, and show a definite advantage in the use of plasma for preventing and relieving hemoconcentration.

Plasma potassium findings were rather disappointing (Fig. 3). Increases in the potassium level did occur in the first 48 hours in all patients except L. T. whose burns were the slightest; however, in no case did the potassium reach a toxic level. It is quite probable that elevations would have been greater had the patients not received treatment, but the important point is that the toxic symptoms of burns were present without the presence of a toxic plasma potassium level.

Since the potassium content of cells is about twenty times greater than that of plasma, whole blood potassium varies almost directly with hematocrit changes and so means very little in itself.

The cell potassium is of interest though somewhat confusing (Fig. 3). The normal variation of potassium in the cells is rather inconstant; however, in general a decrease occurred in most of the cases during the first 48 hours which was followed by a rise. Estimations of the cell hemoglobin content indicate that part of this decrease is the result of intracellular dilution; this may be further confirmation of the concept that the red cells become swollen in shock (6).

In spite of the relatively large amounts of parenteral saline the plasma chlorides consistently decreased slowly, though in no case did this reach a dangerous level (Fig. 4). In contrast, the sodium level fell to a much greater degree. In M. C., F. B., and G. B., the plasma sodium dropped below 130 milliequivalents per liter. This could be a manifestation of adrenal insufficiency in spite of the normal plasma potassium because it has been shown that symptoms of Addison's disease can exist with a normal potassium if the sodium is low. G. B. was given eschatin; this was followed by a rise in the plasma sodium and chloride, but clinically the patient remained in circulatory failure and died.

C. R. showed a definite picture of burn toxemia without lowered plasma sodium, and the remaining cases in general showed no relationship between the plasma sodium level and the presence of toxic symptoms. That sodium may play a large rôle in the morbidity of burned patients cannot be denied, and further investigation is definitely indicated.

Plasma vitamin C determinations were carried out on F. B. Unfortunately, the first sample was not taken until 45 hours after burning; at this time the level was 0.04 milligrams per 100 cubic centimeters. He was then given large doses of ascorbic acid by mouth, and 3 days later the level was 0.14. This man was an old alcoholic and so may well have had a vitamin deficiency before his accident; however, it is interesting to speculate as to whether or not his injury had anything to do with his having such a very low level of vitamin C.

CONCLUSIONS

1. Primary shock, hemoconcentration, and infection may all occur after extensive burns. With adequate therapy these can be controlled, but some patients will still show signs of the toxic stage of burns.

2. The data presented here indicate that under the usual mode of therapy (intravenous plasma and saline) the toxic symptoms may develop and cause death without marked changes in the blood electrolyte pattern. The exception to this may be sodium which is definitely lowered; however, these data indicate no definite relationship between this drop and the clinical picture.

3. We do not imply that blood electrolyte changes are of no importance following burns; such changes must be carefully watched and controlled, otherwise the morbidity and mortality will be markedly increased.

4. Plasma is the ideal parenteral fluid to combat hemoconcentration and should be started within the first 6 hours after the burn is received.

5. Parenteral saline is essential after severe burns as a method to combat the tendency for plasma sodium and chloride to fall and perhaps to prevent elevation of plasma potassium; however, saline must be given judiciously because large amounts bring about a marked decrease of plasma protein, often to the edema level.

6. The value of adrenal cortical hormone cannot be evaluated from our small experience with these preparations.

7. The etiology of the toxic stage of burns is still unknown; the observations here presented indicate that blood electrolyte changes are not the answer. Perhaps a toxin is produced in the burned area. Wilson (31) has demonstrated the presence of a toxin which he believes is formed gradually by the autolysis of the injured tissue, and Rosenthal (17, 18) has found a histaminoid substance in burned tissue which is neutralized by serum from recovered cases of burn—neither of these concepts has been disproved.

I wish to thank Dr. Charles G. Johnston and Dr. J. Logan Irvin for their aid and advice in this investigation. I also wish to thank Dr. O. A. Brines for his aid in the pathological interpretation of the autopsy material presented.

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POSTOPERATIVE INFECTION

Measures of Control

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THE possible sources of contamination of the surgical field are many. Cole and Elman listed them as follows: (1) mouth and throat of the operating room personnel; (2) skin of the surgeon's and assistants' hands; (3) patient's skin; (4) faulty sterilization in autoclave; (5) suture material, chiefly catgut; (6) gross break in aseptic technique; (7) trauma to tissues, poor hemostasis, sutures under tension. To this one may add the fluctuations of immunity and changes in the virulence of bacteria, which may convert a subclinical, unrecognizable contamination into a manifest, clinical infection.

The purpose of this discussion is to describe the methods utilized to minimize the dangers from the sources enumerated and to present statistical data based on the study of clean surgical wounds. All operations were performed at St. Luke's Hospital, Chicago, and some of the suggestions incorporated originated from members of the operating room committee and the surgical supervisors, whose help is gratefully acknowledged.

THE ELIMINATION OF SOURCES OF INFECTION

1. Mouth and throat of the operating room personnel. For several years one of us (G. de T.) has been interested in an inexpensive, easily laundered, comfortable mask, which would efficiently filter the exhaled air of bacteria. It has been repeatedly shown by Davis, Walker, Waters, Blatt, and many others that the ordinary four to six ply gauze mask is permeable to bacteria and that the adequate surgical mask has not been found. Arnold, using the air centrifuge of Wells, has shown that when a person gargled with a 1:100 dilution of a culture of Bacillus prodigiosus and then talked into the Wells machine for 10 to 12 minutes, with his mouth and nose masked with the customary gauze mask, 1,362 bacteria of the same kind were recovered per 10 cubic feet of air. He also showed that the permeability of the mask increased with time. In the first 2 minutes only 20 bacteria passed through, but the count increased with every 2 minute period and during the fifth 2 minutes 317 bacteria passed through per 10 cubic feet of air. Obviously, the ordinary six ply gauze mask when worn for an hour or more is incapable of filtering bacteria. In hot weather the masks are often moist when removed and some surgeons even moisten the mask before use for cooling purposes. Such masks seem quite useless and one wonders whether Hertzler's contempt of masking the mouth or nose does not have some justification as far as the gauze mask is concerned. Gauze or calico masks containing rubber, cellophane, plastigut, or any other impermeable material have not solved the problem. We have tried every one of these. It is true that the impermeable material incorporated into a pocket of the mask prevents a direct spray of bacteria into the wound but they simply deflect the bacterial current and the air of the operating room receives an unfiltered stream of bacteria. The air contamination of the operating room has recently received a great deal of emphasis and the "deflector" type of masks certainly do nothing to minimize this source of contamination.

Obviously, the proper mask has to fit the face closely and permit free breathing through its texture. When Professor Arnold of the Department of Bacteriology was approached to study the bacteriological aspects of this problem he had already possessed some observations relating to the relative efficiency of various textiles to absorb bacteria. Silk, linen, and cotton absorbed bacteria poorly. Wood cellulose, in the form of a creped wadding, called cellucotton showed remarkable

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absorbing qualities. In a series of laboratory experiments, Arnold came to advocate the use of cellucotton as an effective air filter. He pointed out that if all the air could be made to pass through the cellucotton mask the bacteria would remain on the cellulose fibers but leakage around the edges of the mask, which occurs with the average surgical mask, especially with that of the hood type, produces contamination of the air.

The sterilization of the air in operating rooms, as approached with such vigor and ingenuity by Hart and his associates (13, 14, 15), is only a partial and certainly an indirect solution of the problem. As long as it is generally admitted that the degree of air contamination in any room is directly proportional to the duration of occupancy, the number of occupants, the percentage of carriers and the intensity of the air pollution, effective masking seems to be the crux of the situation. The elimination of the carriers has been tried in different services (Meleney, Hart) and has been found to be impracticable. Cultures from the nose and throat change from day to day. The training of student nurses is seriously hampered by their frequent and repeated elimination from the operating room; internes and attending men in a busy general hospital cannot be made to stop their work if their throat cultures become positive. At St. Luke's Hospital the attempt was made for a short period to eliminate all student and graduate nurses from the operating room and the maternity wards whose throat cultures were positive for hemolytic streptococci; the Staphylococcus aureus carriers were not included in this group. Table 1 shows the result of throat cultures on a total of 99 student and graduate nurses over a 10-week period. It is obvious from this greatly abbreviated report that in the fall of 1936, 20 per cent of the nursing staff connected with operating rooms or maternity wards carried hemolytic streptococci. After a short period of elimination of the carriers the nursing school properly pointed out that as long as the attending and interne staff were not cultured the prophylactic value of such a measure was dubious; furthermore, the training of the student nurses was seriously hampered.

TABLE I.—THROAT CULTURES OF THE NURSING STAFF

October 21, 1936—February 9, 1937

	Cases
Negative on first culture	79
Positive on first culture	20
Negative on second culture	7
Positive on second culture	6
Not recultured	7

Of the 6 positives on second culture, 3 remained persistently positive, 2 became intermittently negative, 1 remained persistently negative. Of the negatives on first culture, 3 became intermittently positive. Cultures were taken once a week.

In a personal communication Dr. Frank Meleney stated that during the late winter and early spring months the incidence of positive throat cultures in the personnel amounted to a peak of 35 per cent; they still maintained (February 15, 1937) an elimination of the carriers for the Sloane Hospital as it was felt that on the maternity service the nurses come into much closer contact with the patients, particularly in the postpartum period.

For over a year the cellucotton masks as suggested by the work of Arnold have been in use. Eight layers of cellucotton were placed in a pocket of a large gauze mask; a flexible metal band was inserted into the upper part of the mask, which bent to fit the nose of any individual (Walker) and which prevented steaming of the glasses. There were two objections to this mask. First, it required considerable time to place the cellucotton in the pockets. Second, breathing through the gauze mask with the 8 ply cellucotton was not easy. Some surgeons refused to wear the mask. A few nurses complained of a stuffy odor when the mask was worn for a long time as in the maternity wards.

We then tried a commercial mask, which had an excellent cut to fit any type of face and which contained, as a filter, a variety of compressed cotton. The bacteriological work on the efficacy of this material has been reported by McKhann and his associates. It seems not inferior to cellucotton. Finally the operating room committee adopted a homemade flannel mask which has now been in steady use for almost 2 years. Its use has been adopted by the Canadian Red Cross for Canadian medical services. At present it is in general use at our hospital. The mask is made of a 9 by 6 inch

piece of outing flannel bought on the market for 9 cents a yard.[1] It is inserted between two layers of a 44 by 40 thread mesh gauze. There is one thickness of this gauze on each side. An ordinary one-half inch tape 44 inches long is sewn along the upper and lower border of the mask. Two 1 inch tucks are taken at the two sides of the mask, shortening their lengths to 4 inches and insuring a close fit over the cheeks. A pocket is left for the insertion of a flexible metal band for closer fit on the nose. The cost of the mask to the hospital, including material and labor, is 5 cents. It can be resterilized many times.

2. The skin of the surgeon's and assistants' hands. The most revealing work on this subject has been that of Price. He recommended a soap and warm water scrub of the hands and forearms for 7 minutes, which rids the skin of gross dirt, fat, transient bacteria, and approximately 50 per cent of the basic flora; this is followed by a 3 minute friction (by the clock) with 70 per cent (by weight) ethyl alcohol, which reduces the flora to less than 2 per cent. Ethyl alcohol, 70 per cent, must be prepared by weight and not, as usually done, by volume; ethyl alcohol has a very narrow range of effective germicidal concentration. At 25 degrees Centigrade the following formula will give a solution approximately 70 per cent by weight: 95 per cent alcohol, 815 cubic centimeters, plus cold distilled water to make 1000 cubic centimeters; 60 per cent by weight, approximately 70 per cent by volume, is almost worthless (23). Price pointed out that 1 minute contact with 70 per cent alcohol is equivalent to 4.2 minutes of scrubbing and also suggested a mixture of alcohols which is even more effective, but which we have as yet not tried. Curiously enough the 7 minute scrub followed by 3 minutes' immersion with friction (gauze or washcloth) has been our method of skin preparation for many years.

Beneath the dry rubber glove the bacterial flora doubles in 40 minutes; hence glove punctures are dangerous. Devenish and Miles emphasized the leakage of Staphylococcus aureus through glove punctures occurring during operation; such punctures occurred in 24 per cent of all cases and could be reduced to only 14 per cent in spite of eliminating patched gloves. They felt that the real danger of contamination with Staphylococcus aureus comes not from the nose and throat but from the skin of carriers leaking through the glove punctures or through the sleeves of linen gowns, moistened by sweat. Skin carriers could be best detected by culturing the sweat within the glove at the end of the operation. At our hospital one surgeon, whose incidence of postoperative infection was unusually high, was found to be such a carrier. According to Devenish and Miles a course of ultraviolet radiation had no effect on the skin of one of their carriers.[1]

3. The skin of the patient. Some of our surgeons have closely followed the routine advocated by Koch. Briefly his method is as follows: (1) careful soap and water cleansing with plain white soap of the field of operation on the afternoon preceding the operation. Protection of the cleansed field with a sterile dressing, binder, or towel. (2) A second soap and water cleansing just before operation, for 10 minutes. The soapy solution is rinsed away with sterile water and the sterile draping is applied. No antiseptics are used.

We have followed this procedure for operations on the extremities or orthopedic work. For the majority of patients, however, our choice is still an iodine-alcohol preparation. With the exception of an occasional case of iodine sensitivity, of which the patient is usually aware, we have not experienced the much discussed iodine dermatitis. It is essential, however, to apply the 5 per cent tincture of iodine once, carefully to remove the excess with alcohol and then to apply a third dry swab, the remaining iodine and alcohol being wiped off. The edges of the prepared field, which are covered by sterile towels, are carefully wiped off. Trickling of the tincture of iodine into genitorectal areas or to the back of the patient is avoided. We have returned to the iodine-alcohol preparation after a thorough

[1]The types of Canton flannel which serve as effective bacterial filters have been given to us by Dr. C. F. McKhann as Cinderella, Edwards SF-124 and Edwards SF-125. We gratefully acknowledge Dr. McKhann's help. A study of these masks is being continued. Of 9 masks studied by Dr. McKeever of our resident staff, the one in present use proved to be most efficient.

[1]Many believe that 1:2000 bichloride of mercury on hands that will tolerate it, following alcohol, is an added safeguard.

trial of the mercuric-chloride-acetone-alcohol mixture of Arnold, of mercurochrome, mercresin and metaphen. While in a large general hospital, such as ours, every surgeon has his own favorite method, a gradual return to iodine is noticeable. A 2 per cent iodine solution in 70 per cent (by weight) of alcohol has been advocated by Price. It is inexpensive and has an important quality which test tube experiments for antiseptic coefficients will never demonstrate, i.e., it produces a reactive hyperemia of the skin, which we have demonstrated with measurements of skin temperature; this together with a local leucocytosis is an excellent adjunct to primary union. For certain regions of the body, such as the genital, anal, and axillary regions, a 3 per cent aqueous solution of iodine has been employed with lack of iodine dermatitis, provided the field is carefully wiped off with a dry sponge.

The fingering of the prepared skin with the gloved hand to outline the line of incision is inconsistent with the customary efforts to cover the incised skin with towels and isolate the wound with towel clips. If preliminary marking of the line of incision is desired, we advocate the use of a two per cent solution of brilliant green applied before the iodine-alcohol preparation. Mercurochrome and metaphen solutions efface the brilliant green mark.

4. Faulty sterilization in autoclaves. This subject was reviewed by Dandy in 1932. He advocated sterilization in an autoclave for one hour with a constant pressure of not less than 20 pounds. Meleney stated that sterilization for 30 to 45 minutes and prolonging the evacuation time at minus 10 to 15 minutes was sufficient to kill organisms and spores. With less time and pressure the center of the central drum may remain contaminated. At St. Luke's Hospital, 18 pounds of pressure are used for 1 hour followed by another hour of vacuum. A temperature of 250 degrees F. is obtained.

5. Suture material. The whole subject of catgut versus silk (11, 12, 17, 25, 31) and the recent work of Meade and Ochsner with cotton cannot be entered here. We simply wish to present our own procedure, learned in the schools of Kocher and developed in this country by Halsted. We use silk, and as fine a silk as possible, unless some definite contraindication exists. The silk is usually interrupted, the peritoneum is closed with a continuous catgut suture and catgut is used in entero-anastomoses for the suture of the mucosa. Infection is not a contraindication to silk, and we have repeatedly tied large vessels with heavy silk or even tape in the presence of infection. We believe that the steady use of catgut increases the incidence of infections not only because the sterilization of catgut is not as simple but mainly because catgut produces local areas of exudation, and collections of serum predispose to infection. It must be admitted, however, that if catgut were used in such fine varieties as silk is, the difference between the true materials might not be so striking (17). If cotton continues to be as successful as the first reports indicate (21), we may look for a further improvement in suture material. It has been tried on our service in over 100 major operations.

6. Gross break in aseptic technique. In large hospitals with student nurses and internes rotating every 6 weeks in the operating room, with a large surgical staff whose training is not always of identical nature, a break in asepsis has to be continuously guarded against. Visitors should always wear sterile caps, gowns, and have their mouths and noses covered. Visitors in nonsterile gowns when they lean against the drapings or the exposed backs and elbows of the surgical team are a definite menace. The dripping of perspiration from the foreheads of the surgeons and assistants is a frequent source of danger. We have tried some of the sponge-mops which are on the market, but their wear is cumbersome and may increase perspiration. While air conditioned operating rooms eliminate much of the perspiration, large blocks of ice placed in front of a fan have been tried; their use may be objected to as they stir up dust in the operating room and facilitate the migration of bacteria toward the wound.

A frequent source of a sudden spray of dust and bacteria is the sudden shifting of the lighting system directly over the field of operation. When such a shift becomes necessary it is wise to cover the field with a sheet during this maneuver.

7. Trauma to tissues, poor hemostasis, sutures under tension. One hardly needs to belabor the point that rough handling of tissues, insufficient hemostasis, sutures under tension, which invite localized areas of ischemia, favor the multiplication of ever present bacteria; it is less often realized that foci elsewhere in the body may be stirred up by the trauma of the operation and anesthesia and bacteria may then localize in the surgical field. This is particularly true of acute respiratory infections. During an influenza epidemic in a large base hospital, one of us observed the suppuration of many clean wounds that had been healing without reaction for 5 to 7 days. When the epidemic hit the clean surgical ward a large percentage of the wounds became infected with bacteria, which are secondary invaders following the virus, namely, the Streptococcus hemolyticus, and the Staphyloccus hemolyticus. A patient, then, should never be operated on except in emergencies when a respiratory infection is present; not only because of the danger of postoperative pulmonary complications but because of the possible localization of bacteria in the surgical field. The classic experiment of producing a localized abscess at the site of trauma following an intravenous injection of bacterial suspension is sufficiently known, but its application to the localizing effect of surgical trauma is often ignored.

8. Other sources of infection. Another source of infection in postoperative wounds is the presence of bacteria in a latent "resting" state in the tissues. This problem in its relation to the activation of phlebitis in varicose veins has been discussed elsewhere (8). The principle of activating resting infection by surgical trauma and especially by creating anaerobic or partially anaerobic conditions has an important application in all surgical operations where potentially infected fields are invaded. Gas gangrene following amputations for vascular disease is an example (9). The torn or overstretched muscle of a muscle splitting incision may be of more harm to the patient than a clean, sharp cut in the muscle, provided it does not damage its nerve supply.

That more infection does not result from such endogenous sources is no doubt due to the patient's immunity. This immunity may be local, developing around a chronic anal fistula, or general. But the immunity of patients to specific bacteria varies from day to day. Schafer found that in the months of January and February immunity of animals is at its ebb for diphtheria. Epidemics of scarlet fever are explainable not by the sudden appearance or multiplication of bacteria but by a sudden decrease of immunity. The sudden overwhelming septicemia following clean operations, which, according to Hunt, occurs in 1 of 2000 to 3000 cases may be explained in the absence of any recognizable source of infection by such a sudden loss of immunity.

Mrs. D. T. a 42 year old rather obese woman had a small epigastric hernia which was repaired under local anesthesia. An all-silk technique was used. The operation lasted 36 minutes. On the night of the operation the patient had a severe chill; within 24 hours she died of a fulminating septicemia. Hemolytic streptococci were cultured from the blood, the spleen, and other organs. The field of the operation showed no infection. All possible sources of infection were checked. Throat cultures of the operating room personnel were negative. The procaine solution was sterile. The silk, as usual, was sterilized with instruments in boiling water for 10 minutes. The patient's throat was slightly infected; unfortunately, no culture was made from it.

Such a case, which may occur in the practice of any surgeon, illustrates the difficulty of detecting some sources of infection or preventing their occurrence.

MATERIAL STUDIED

The purpose of our present study was to see what results were obtained with the methods here outlined, to emphasize the weak points, and, if possible, suggest their remedy. The material to be presented illustrates the results obtained in a general hospital in which yearly over 7,000 major operations are performed. As some of the special sheets were incompletely filled out, we can present data on only 606 clean operations. An infection sheet was attached during the year of 1938 to the hospital record of every major surgical case. The classification of postoperative infections is that of Claude Beck as reported by William C. Beck in his recent survey on morbidity caused by operative complications (Table 11). For a check on our operating room technique we could utilize only the first

TABLE II.—RECORD OF INFECTION

Date_____

Nature of operation_____

A. Clean wounds
B. Potentially infected wounds or drained cases
C. Frankly infected wounds
   0. Primary union
   1. Reddened skin edges
   2. Stitch abscess
   3. Wound infected requiring slight opening
   4. Wound completely opened
   5. Hematoma
   6. Infected hematoma
   7. Necrosis of skin edges
   8. Eventration
   9. No suture employed, healing by granulation
   10. Septicemia

group of clean wounds, which included herniotomy, thyroidectomy, aseptic bone and tendon operations, and radical amputation of the breast. To these we added laparotomies, provided no acute infection was present or no opening of the bowel became necessary. Many records had to be rejected as being incomplete or because contamination from the patient could not be excluded.

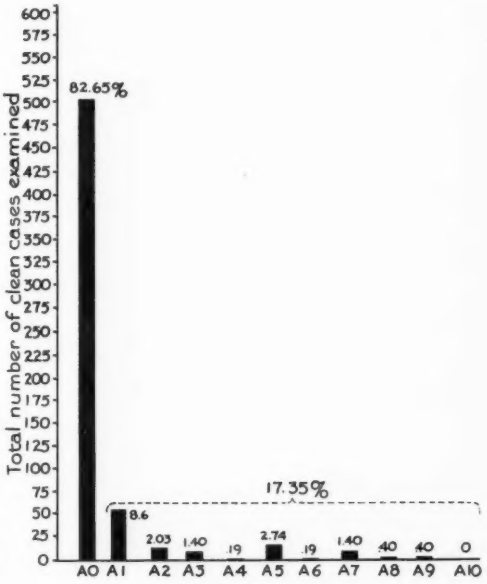

Chart 1. Classification of clean cases.

THE RESULTS

Of the 606 cases, 501, that is 82.65 per cent, healed by primary union, thus leaving a group of 17.35 per cent with some disturbance of wound healing (Chart 1). A glance at our record sheet, however, will show that A_5 and A_7, representing hematoma and necrosis of skin edges are really not due to infection but have been included in this survey as they predispose so readily to it. Reddened skin edges seem to constitute the highest single percentage of complications. They are obviously due to contamination from the skin at the time of operation or possibly during the course of healing. As the residents were asked to record even the slightest hyperemia around the margin of the wound, this figure probably represents the mildest inflammatory reaction.

The 2.03 per cent of stitch abscesses unfortunately could not be divided into those due to catgut or to silk. The majority of our surgeons, however, are using catgut. On the fourth surgical service of Dr. William F. Lyon and one of us (G. de T.) silk is used almost exclusively. Postoperative infection resulting in prolongation of hospital stay or danger to life as represented by groups A_3, A_4 and A_{10} occurred in 1.59 per cent of the cases.

In order to get closer information for the causes and future elimination of these reactions, the material was cross examined according to the operative procedures and the varieties of wound healing.

Of 143 herniotomies, 10.4 per cent had reddened edges and 3.7 per cent had a hematoma (Chart 2). This finding emphasizes the importance of adequate preparation of the pubic skin, which is often neglected, and careful hemostasis. Again the possibility of postoperative contamination should be mentioned. The comparatively small number of thyroidectomies is explained by the fact that many infection sheets were returned unfilled, probably indicating primary union. Nevertheless, as they were not marked as such they could not be used. Again, reddening of the skin and hematoma are the two complications listed. Hysterectomies showed a remarkably high percentage of the group belonging to A_1, namely, reddened skin edges. Whether this is due to a different preparation of the skin on this service, to a more conscientious filling out

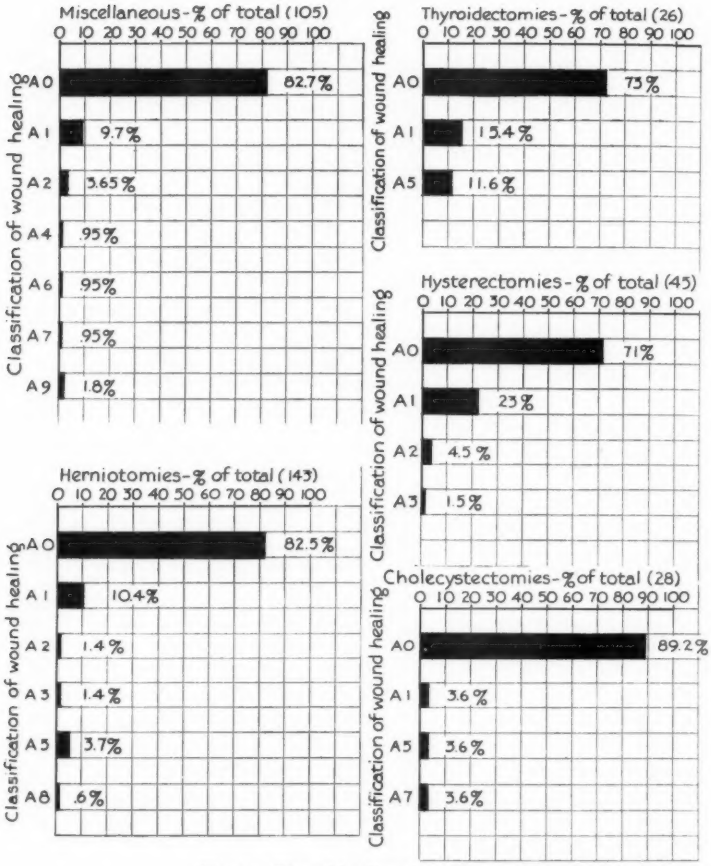

Chart 2. Wound healing classification.

of the record by the resident on gynecology, or to the difficulty of sterilizing the field, is uncertain. This service has since cut down the percentage to a small minimum. Cholecystectomies show a very high percentage of primary wound healing—89.2 percentage. In this hospital drainage is used in all cases for 2 to 4 days. In a miscellaneous group, including neurosurgical cases, vascular surgery, plastic surgery, thoracic and genito-urinary patients, wound healing compared favorably with most other groups, owing perhaps to the special preoperative care of these patients.

Appendectomies did equally well with the exception of minor skin infections (Chart 3). The statistics on bone and tendon operations are favorable especially in regard to the low incidence of minor skin infections and of hematoma. Following mastectomies, necrosis of the skin edges seemed to be a complication too often encountered. This is obviously due to the effort of removing as much skin as possible or saving too much undermined skin and may point to a more frequent use of immediate or delayed skin grafts. Other laparotomies behaved much like the average group.

When the operative procedures are grouped according to the postoperative reaction, the points mentioned obtain renewed emphasis (Chart 4). Primary union, A_0, showed the highest percentage following cholecystec-

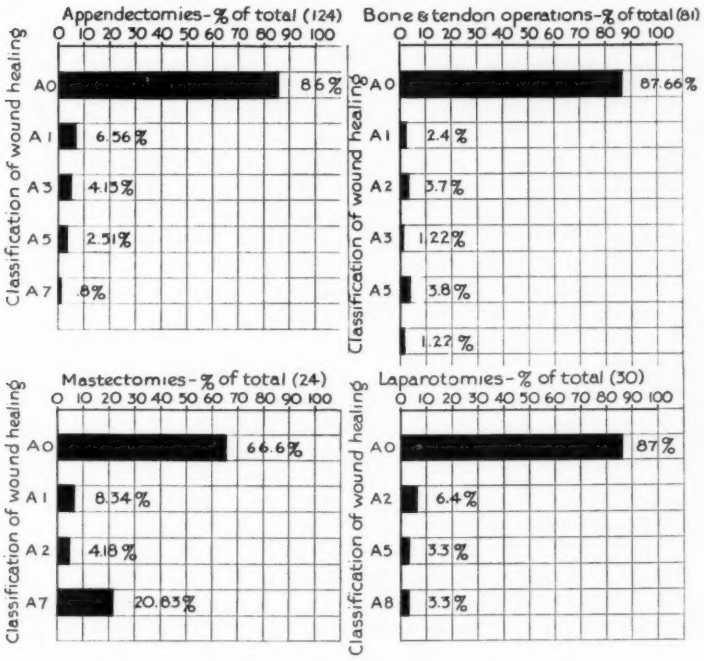

Chart 3. Wound healing classification.

tomies and orthopedic operations; the lowest percentages were encountered following hysterectomies and mastectomies. Reddened skin edges were encountered in 20.3 per cent following hysterectomies and only in 2.4 per cent after orthopedic operations. Stitch abscesses, A_2, were seen most often after laparotomies and least frequently after herniotomies. Slight serous or purulent discharge was seen most frequently after appendectomies, indicating the necessity of careful protection of the abdominal wall from contamination and the occasional use of drainage or delayed closure as advocated by Coller and Volk. Hematomas were most frequent after thyroidectomies, which, of course, is due to the nature of the operation. We have commented on the large percentage of skin necrosis following mastectomies.

EVALUATION OF RESULTS

The difficulties in evaluating the results of such a survey are obvious. In a general hospital, the technique of different services and of individual surgeons varies. There were, of course, certain nonvariables, such as (1) the sterilization of instruments, suture material and surgical linen, and (2) the new air-filtering masks, which we do believe have an important rôle in diminishing air borne infection. The incidence of stitch abscesses, slight and serious wound infections, infected hematomas and septicemia totals 3.81 per cent of all clean operations, a truly excellent record compared with other carefully conducted surveys (22). On the basis of some experience with trying to establish the incidence of surgical infections from the ordinary hospital records, we have to come to the conclusion that aside from being a cumbersome and lengthy task, many minor infections are unrecorded and perhaps never known to anyone but the interne removing the stitches. We believe that in order to get comparative results, similar record sheets would have to be used by all institutions really interested in their per-

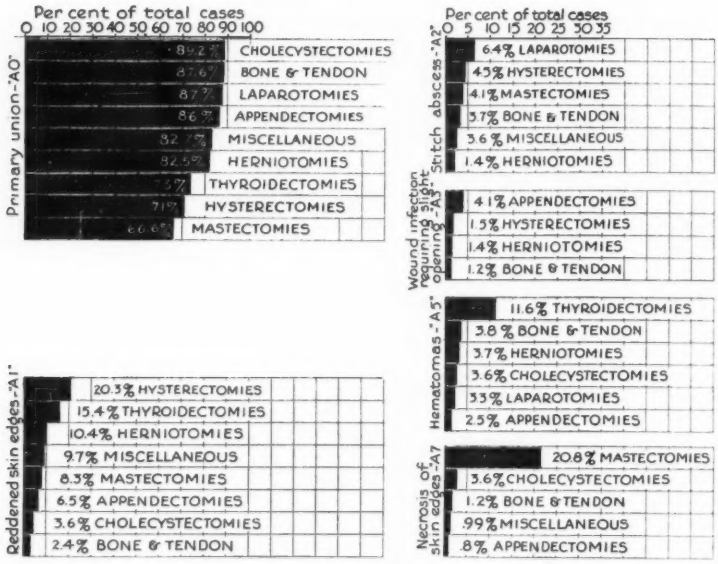

Chart 4. Operative procedures grouped according to wound healing.

centage of disturbed or delayed wound healing. The survey of William C. Beck offers a standardization of such studies.

The reddened skin edges are undoubtedly due to inadequate sterilization of the skin or a postoperative contamination of the wound. The gynecological service, on which 1 per cent mercurochrome was used, had the highest incidence. The highest and lowest percentages were 20.3 per cent and 2.4 per cent. In addition to the soap and water, iodine and alcohol preparation, we advocate two other measures to prevent delayed contamination of the skin after it has been sutured. One is the use of silverfoil, under which we have never seen a true cutaneous infection, the other is the gluing of the gauze dressing to the skin with mastisol,[1] which one of us (G. de T.) has been using since 1915 and which makes excellent small dressings for aseptic wounds. The importance of late skin infections is best seen in the many ambulatory vein ligations. In the hot summer months, where perspiration can readily increase the incidence of bacteria around the suture line, reddened skin edges are far more frequently encountered. In over a thousand ambulatory vein ligations, which are not included here, mastisol was used but no silver foil or antiseptic dusting powder has been employed. During the hot spell of July, 1940, we became convinced, however, that ambulatory patients, especially, require added care for the protection of the suture line from cutaneous bacteria. The pubic area is especially prone to minor skin infection, which may explain the high incidence after hysterectomies and inguinal hernias.

The results obtained here are readily surpassed by the individual surgeon who is especially conscious of postoperative infections. In surveying the practice of other hospitals one surgeon stated that "postoperative infection has occurred so infrequently that we have almost stopped thinking about it." This may be true of some surgeons of our institution. We were really interested, however, in determining the chances that the average patient has of developing an infection when operated on at St. Luke's Hospital. We have used rigid criteria for the establishment of the data published here.

It seems as if there is an irreducible mini-

[1]Gum mastic, 40 grams, benzol, ad 100 gram. Filter, then add guttas 20 of castor oil.

mum of infection following clean cases. We will have to pay more attention to the sterilization of the skin and to glove punctures. We are not in a position to evaluate the bactericidal effect of radiant energy on the contamination of the air in the operating room, but it is our feeling that the use of effective air filters in closely fitting masks is another step in the same direction, certainly a simpler one. Perhaps the mouth and pharynx of the operating room personnel could be temporarily sterilized with tablets or trochees, but there is no good evidence yet that this is practicable.

The fluctuations of immunity and their relation to sudden overwhelming infection is another open question; only slight use has been made in this hospital of the prophylactic doses of sulfanilamide before operations that readily lead to contamination from within the body, such as intestinal resections.

Whether the contamination with Staphylococcus aureus comes from the nose and throat of the personnel in the operating room (13, 14) or whether it is skin contamination (10) is impossible to decide. In an excellent review of the problem of air contamination, Walters and Magath lean toward the view that air contamination through respiratory passages and its effective sterilization by radiant energy is far from being proved. Certain it is that expensive and complicated ultraviolet radiation in operating rooms is still in the experimental stage and need not as yet burden the budget of the average general hospital.

SUMMARY

1. The sources of contamination of the surgical field have been discussed. The use of a new flannel mask has been described which efficiently filters bacteria but does not deflect them. The sterilization of the skin of the patient with soap and water, followed by iodine and 70 per cent alcohol, is advocated. Measures have been suggested which seal the suture line following operation. Silk was preferred to catgut.

2. Following the classification of Claude Beck, 606 clean operations have been studied in regard to their postoperative wound reaction. Postoperative infection resulting in prolonged stay in the hospital or danger to life occurred in 1.59 per cent. A total of 3.81 per cent of all clean operations showed wound infection. Special interest has been focused on reddened skin edges as evidence of inadequate sterilization of the skin. Hematoma and marginal necrosis occurred more frequently in certain types of operations. The material was studied according to operative procedures and plotted against the different grades and types of delayed union.

3. The study is intended to stimulate similar efforts of record keeping in other hospitals. As a result of our own survey, further improvement in our records has already taken place. The filling out of the record is simple, not time consuming, and should be entrusted to the resident.

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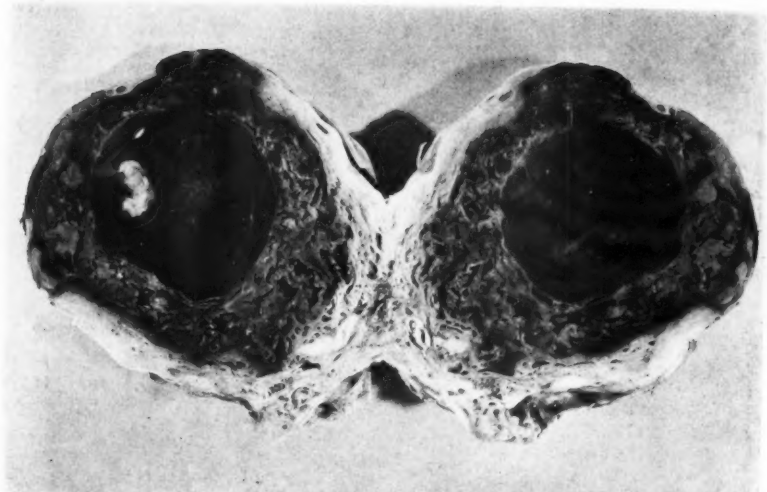

Fig. 1. Photograph of unruptured primary ovarian pregnancy. Bisected ovary measured 5.5 by 3.5 by 6 centimeters.

Fig. 2. Photograph of portion of hemisected ovary revealing fetus attached by body stalk and membranes. × 3. (Photography by Clarence B. Mitchell.)

Unruptured Primary Ovarian Pregnancy.—Arthur H. Curtis.

UNRUPTURED PRIMARY OVARIAN PREGNANCY

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THE literature concerning ovarian pregnancy is incomplete and confusing, particularly in regard to the incidence of this abnormal type of gestation. Some of the factors responsible for the inadequacy of our knowledge of this subject are perfectly obvious, as will be evidenced by the discussion which follows the description of the one case which has come under my observation, recorded herewith:

A patient of 34 years whom I had known since early childhood and who had reported for a premarital examination one and one-half years previously, at which time there was no evidence of abnormality except considerable retrodisplacement of a freely movable uterus, complained of infertility which had persisted for more than a year despite dietetic and hygienic measures and thyroid medication. Infertility was her sole complaint.

Examination revealed the cervix tilted far anterior, the uterus badly retroverted, the pelvis otherwise entirely negative, no palpable evidence of adnexal abnormality or endometriosis. In an attempt to relieve the sterility, our first recourse was simple, thorough office dilatation of the cervix, on February 7, 1940. This old time measure for relief of infertility was employed despite normal regular comfortable menstruation. Two weeks after the dilatation, for the first time in her experience the patient had a profuse prolonged menstrual period of 12 days' duration. The next menstruation, due early in April, was 2 weeks delayed and was a rather free steady flow of 8 days' duration, painless and free from clots. The patient reported for examination 1 week thereafter, on April 29, 1940, with a story of slight irregular spotting since her menstrual period and marked daily nausea solely in the afternoon; otherwise there were no symptoms except vague pelvic discomfort. The previously mobile uterus was now rather fixed in retrodisplacement, not palpably enlarged, the right adnexa negative. A cystic non-sensitive mass the size of a lemon was palpated in the region of the left ovary.

Despite the absence of bogginess and despite the presence of a mass with a definitely cystic contour, it appeared that a tubal pregnancy was more likely than ovarian pathology. In this patient with infertility, a heavy badly retrodisplaced uterus, and evidence strongly suggestive of ectopic gestation, I advocated immediate exploration without delaying for a Friedman test and without recourse to a posterior colpotomy exploration.

Operation the next morning revealed a retrodisplaced edematous uterus one and one-half times normal size, the fundus deep in the cul-de-sac, three pea- to hickory nut-sized fibroids buried in the uterine wall. The uterus was somewhat imbedded but easily elevated despite innumerable scattered "shaven-beard" endometriotic implants in the cul-de-sac peritoneum.

The right ovary was prolapsed and edematous; it was studded with several minute superficial endometriotic implants which were easily removed by gentle rubbing. The right fallopian tube had unusually large fimbriae, the ovarian fimbria remarkably developed and forming a veritable trough leading to the ovary. Despite the enlarged extremity of the tube, there was only the tiniest pin-point opening which was readily dilatable with scissors; air was then passed freely through the tube into the uterus by means of a syringe and adapter.

The left fallopian tube was a counterpart of the right, but the ampullar opening was not tested. The left ovary occupied a relatively normal position, independent of the tube, and was converted into a hemorrhagic cyst the size, shape, and color of a large, freshly washed, deep red medium sized peach.

The operative procedures included a left ovariectomy, multiple myomectomy, removal of endometriotic implants from the right ovary, dilatation of the phimotic right tube followed by air syringe determination of tubal patency, and an abdominal replacement operation. The left fallopian tube was spared to insure a more satisfactory support after the replacement operation.

Gross description: The freshly removed hemorrhagic fluctuant ovarian mass measured 5.5 by 3.5 by 6 centimeters. The surface was a mahogany red, the consistency soft, suggestive of deeply seated fluid content beneath a very thick shell of tissue.

Hemisection after fixation in Kaiserling solution (Figs. 1, 2) revealed an intact wall varied from 0.5 to 2 centimeters in thickness. The cut surface was uniformly red-brown except for a 2 to 4 millimeter shell of gray-white, normal appearing ovarian tissue which encased two-thirds of the circumference of the solid wall, within which was a central cavity. No corpus luteum was evident. The spherical cavity, filled with clear liquid, was lined by a smooth glistening membrane; it measured 2.5 centimeters in diameter.

An intact curled fetus, 12 millimeters in length, as fixed in the Kaiserling solution, was supported by filmy membranes and a clearly distinguishable body stalk attached near the caudal end.

Microscopic study of the wall which enclosed the sac containing the fetus revealed typical chorionic villi with well preserved syncytial and Langhans cells (Fig. 3). There was no evidence of a decidual reaction.

In this instance it is superfluous to state that the specimen meets the requirements of Spiegelberg's specifications for the diagnosis of a "primary" ovarian pregnancy.

A problem of academic interest confronts us: The fallopian tube was in no way attached to the ovary except that, as previously mentioned, there was a veritable trough from the fallopian tube to the ovary created by an unusually developed fimbria ovarica. The question arises as to whether Leopold was justified in establishing the belief that primary (true) ovarian pregnancy results solely from fertilization of the ovum before its escape from the graafian follicle. In this instance, in which we have to do with an undoubted case of primary ovarian pregnancy, it is of interest to

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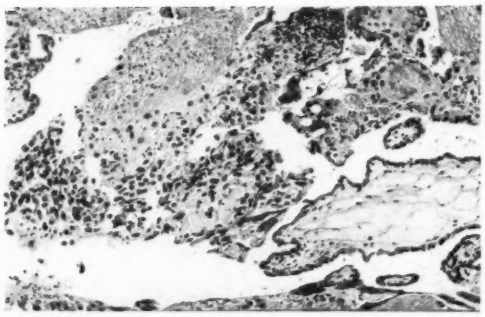

Fig. 3. Photomicrograph of ovarian wall. Chorionic villi, deeply staining syncytial cells and clear Langhans cells.

note that the pregnancy occurred in a patient in whom there was a veritable toboggan slide from the fallopian tube to the ovary. Just as fertilization of the ovum in the tube is a preliminary stage in the everyday occurrence and development of normal intra-uterine gestation, likewise it should be possible for the impregnated ovum to skid downward into the gaping recently ruptured ovary, there to develop. Whether an endometriotic implant must furnish a favorable site for nidation of the ovum, as was possible in this patient with endometriosis, is an additional problem, mention of which may suffice here.

Nearly 100 cases of primary or "true" ovarian pregnancy have been recorded in the literature; of this number only approximately 60 are authentic instances of primary ovarian gestation. Despite the fact that only a small number of cases are recorded in the literature, and many of these cannot be accepted as authentic, primary ovarian pregnancy is probably not at all rare, and it very likely explains a considerable proportion of the cases of serious hemorrhage from the ovary; also, it doubtless accounts for some instances of secondary abdominal pregnancy—a much more common affection than has heretofore been realized. (Lull has had 5 cases of abdominal pregnancy in his own practice.)

CONCLUSIONS

1. A case of living unruptured primary ovarian pregnancy has been described.

2. Evidence has been submitted in substantiation of the thesis that primary ovarian pregnancy may occur after fertilization in the fallopian tube, just as normal intra-uterine gestation develops after fertilization in the fallopian tube. The belief that primary ovarian pregnancy occurs solely after fertilization of the ovum before its escape from the ovary is unwarranted.

3. Despite the fact that only a small number of cases of primary ovarian pregnancy are recorded in the literature and a considerable proportion of these are not authentic, it would appear that ovarian pregnancy often escapes recognition and it is always to be considered in cases of ovarian hemorrhage which are serious enough to require surgical intervention.

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THE DISRUPTION OF ABDOMINAL WOUNDS

A Continuation of a Previous Report

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OVER 3 years ago we reported 22 cases of disruption of abdominal wounds (1) occurring in a series of 2,927 patients on the surgical service of the New York Hospital during a period of 3 years and 8 months. Since the mortality of this serious complication continues to be from 22 to 50 per cent in various reported series we have again reviewed our experience with an additional 3,490 cases and consider in this study, therefore, a total of 6,417 abdominal wounds. From the data collected in the study of the first series of 2,927 patients certain conclusions were drawn leading to the application of general policies in the second series of 3,490 patients treated over a similar period of time. The value of such a study is suggested by the results since in the first series the incidence of evisceration was 0.75 per cent and in the second series 0.60 per cent. More significant perhaps is the difference in mortality rate as that in the first series was 45.45 per cent while in the second series it was 19.04 per cent, a mortality rate of 30.2 per cent for the total of 43 eviscerations.

In the continuation of the comprehensive study of this problem of wound disruption on the surgical service of the New York Hospital, the records of all patients upon whom abdominal operations were performed between September 1, 1932, and January 1, 1940, were reviewed with respect to the following factors: location of the incision, suture material used in closing, the operation performed, the lesion, whether malignant or nonmalignant, and whether infection was present previous to operation or presumably introduced during the operative procedure. Our total of 6,417 abdominal wounds were followed by 43 eviscerations, an incidence of 0.66 per cent. The general information concerning the series is presented in Table I.

In Table II the influence upon the incidence of evisceration of the site of incision and the type of suture material employed, together with an evaluation of the incidence of wound evisceration for the entire period, are presented.

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Table III approaches the subject from a different viewpoint. Here the figures are given for incidence of evisceration in various operations and again reference is made to the suture material employed.

Table IV summarizes the distribution of suture material employed. It is to be observed that catgut has been used with increasing frequency and we feel that an interpretation of this point is worthy of discussion. The indications for the use of silk have been more rigidly adhered to from year to year. Catgut has, therefore, had to bear the brunt of all cases of infection or possible infection. The incidence of wound evisceration, however, has been almost equal in the two obviating, therefore, any preference for safety in so far as wound closure is concerned.

TYPES OF CLOSURE

1. *Catgut closure.* a. Interrupted catgut closure. The peritoneum is closed with a continuous suture of No. 0 plain or No. 1 20 day chromic catgut. The fascia is approximated by a series of interrupted sutures of chromic catgut No. 1. Stay sutures of silkworm or "dermo" are placed so that they embrace the fascia only.

b. Interrupted catgut closure with figure-of-8 sutures. This is a modification of a; instead of interrupted chromic sutures, the figure-of-8 type of suture with No. 1 20 day chromic is employed.

c. Interrupted catgut closure with drainage. No. 1 20 day chromic catgut is used to close the peritoneum. Instead of one continuous suture, one continuous suture starts from each extremity of the wound and is brought to the point where the drain emerges. At this point on either side of the drain, a single reinforcing suture of the same material is placed. The single suture is referred to as a "safety suture." The fascia is closed in the manner described and stay sutures complete the closure.

2. *Silk closure.* a. Silk closure without drainage. A continuous suture of twisted surgical silk No. 7 approximates the peritoneum, and interrupted sutures of the same material unite the fascia. When stay sutures are employed they are of the same silk and form a lateral figure-of-8, in-

TABLE I.—GENERAL INFORMATION

Number of abdominal operations	6,417
Total eviscerations	43
Incidence, per cent	0.66
Deaths	14
Mortality, per cent	30.2

cluding the fascia. The subcutaneous tissues and skin are closed with interrupted silk (No. 5) sutures.

b. Silk closure with drainage. This closure is the same as b in previous list except that silk, No. 7, is used in place of catgut. The safety sutures of silk are employed. Stay sutures may or may not be used; the subcutaneous tissues are not approximated, unless they are unusually thick. Ordinarily the deep skin sutures (No. 5 silk) suffice to bring these tissues into approximation and reaction around the drain is less likely to persist in the surrounding tissues if sutures are omitted.

3. *Silk and catgut closure.* A continuous suture of No. 0 or No. 1 plain catgut or No. 0 or No. 1 chromic catgut is used for the peritoneum. The fascia is approximated by interrupted sutures of twisted surgical silk, No. 7, or figure-of-8 sutures of the same material. Interrupted sutures of silk No. 5, are used to approximate the subcutaneous tissue and skin. Stay sutures, when employed, are buried, consist of double silk, No. 7, and form a vertical figure-of-8 without including muscle.

4. *Silver wire closure.* This is the through-and-through silver wire closure as described by Reid, Zinninger and Merrill. A suture of silver wire on an atraumatic needle is introduced from the skin through the subcutaneous tissues and fascia down to and through the peritoneum, and is then returned to the skin, layer by layer. Silver wire sutures of No. 20 round wire should be inserted about 3 centimeters apart and when all have been placed they are drawn taught and each one is secured separately by twisting. No guards to protect the skin from the wires are employed.

In our previous report we warned against the use of silk and catgut in the same wound. The 77 cases reported here of closure of abdominal wounds with silk and catgut show none of the unfavorable complications that we have suggested. The definition of a silk and catgut wound is, however, demanding of explanation. The use of a silk suture, or a catgut suture to the peritoneum with silk ligatures and silk sutures to the fascia, subcutaneous tissue and the skin does not present the same situation as does the use of both catgut and silk material for suture and ligature in the more superficial layers. The use of a long, continuous silk suture to the peritoneum is objected to by some surgeons because, they contend, it produces a permanent distortion of the peritoneum. Furthermore, they object to its use on the ground that if the wound becomes infected a protracted time is required for the expulsion of the continuous silk suture, during which period a foreign body sinus persists.

TABLE II.—SITE OF INCISION AND SUTURE MATERIAL

Incision	Catgut	Silk	Catgut and Silk	Silver wire	Total	Eviscerations	Per cent
Upper right rectus	1541	479	46	249	2315	26	1.12
Upper left rectus	98	95	2	34	229	3	1.31
Lower right rectus	368	109	1	28	506	3	0.59
Lower left rectus	207	42	3	30	282	6	2.12
McBurney	1556	1009	20	2	2587	2	0.08
Upper midline	1	28	0	2	31	0	0
Lower midline	105	49	0	7	161	0	0
Mid midline	4	35	0	0	39	0	0
Mid right rectus	53	60	5	20	138	1	0.70
Mid left rectus	10	6	0	0	22	1	4.54
Paracostal	17	3	0	2	22	0	0
Transverse rectus	6	10	0	3	19	1	5.26
Transverse umbilical	4	60	0	2	66	0	0
Total	3970	1985	77	385	6417	43	0.05

We have felt an added security in the use of through-and-through silver wire closures and although the incidence of wound disruption in our series of 385 is 1.29 per cent, we believe that this would have been much higher in the same group of cases with any other suture material. The indications previously set up have been the basis for its use. We recommend that "silver wire closure be used in the presence of massive abdominal infection, in wounds which have been grossly contaminated by gastrointestinal contents, and in all cases debilitated by malignancy or long standing chronic disease associated with anemia," as well as "for the secondary closure of disrupted wounds."

Our experience as detailed in Table V continues to be rather unique in the preponderance of disruption in male patients as compared with other reports in the literature. This is most nearly approached by Meleny and Howes who report 70 per cent eviscerations occurring in male patients. The total incidence here is approximately 90 per cent male patients who have had wound disruptions.

TABLE III.—OPERATION, SUTURE MATERIAL

Operation	Catgut	Silk	Catgut and silk	Silver wre	Total	Eviscerations	Per cent
Appendectomy	1778	1043	22	8	2851	5	0.17
Biliary tract operations	1009	147	32	102	1290	12	0.92
Stomach operations	383	113	13	136	645	10	1.55
Small bowel operations	75	28	1	27	131	1	0.76
Large bowel operations	337	159	3	60	559	11	1.96
Pelvic operations	178	40	0	2	220	0	0
Exploratory operations	132	125	5	27	289	2	0.69
Ventral hernia repair	31	232	0	3	266	2	0.75
Splenectomy	8	52	0	3	63	0	0
Umbilical hernia repair	0	12	0	0	12	0	0
Miscellaneous	39	34	1	17	91	0	0
Total	3,970	1,985	77	385	6,417	43	0.65

ANALYSIS OF EVISCERATIONS

No age is immune, evidently, from wound disruption as our youngest patient was 8 months old and the eldest 76 years of age. The majority, however, are to be found in the fifth and sixth decades, or in the age in which malignancy is most likely to occur.

In our previous report we noted that our findings were in agreement with those of many authors in that we reported an incidence of wound disruption of 1.20 per cent in abdominal wounds for malignant disease which was almost twice the incidence of wound disruption in nonmalignant cases. Since that report our experience has been even more striking for in 557 patients with malignant disease there were 10 eviscerations, an incidence of 1.8 per cent. In 1,139 patients with malignant disease there were 16 eviscerations, an incidence of 1.39 per cent, while in the same period 27 eviscerations occurred in 5,278 patients without malignant disease, an incidence of 0.51 per cent, giving us now an incidence of wound disruptions almost 3 times greater in malignant disease than in nonmalignant disease. Paralleling the importance of malignancy from the standpoint of the possibility of wound disruption is the associated high mortality rate, for in the 16 patients having wound disruptions in malignant disease the mortality rate was 56 per cent, whereas in nonmalignant cases the mortality rate was 18.51 per cent.

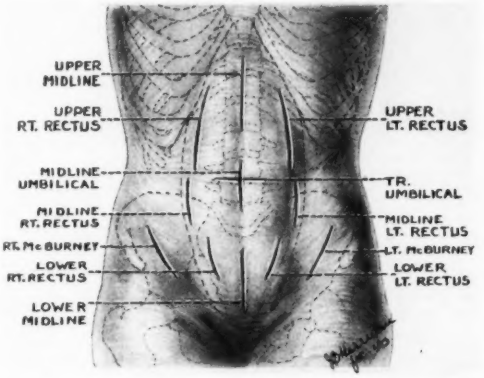

Fig. 1. Location and designation of incisions employed.

Of all the known predisposing factors to wound evisceration, debility has received the greatest emphasis. This term is a comprehensive one and is generally used to denote weight loss, weakness, anemia, and early fatigue on exertion, commonly seen in patients suffering from malignant disease and especially those whose malignant lesion is ulcerated with resultant bleeding and infection. In our first series of eviscerations there were 11 patients labeled as being debilitated prior to operation, while in this series of 21 patients there were 8. The red cell count ranged from 2.5 to 5.9 million and in many instances the recorded pre-operative red blood count was done after numerous transfusion. The significance of avitaminosis has become more important in our experience and for this reason we are at the present time insistent that those vitamins known to be concerned with wound healing, in particular

TABLE IV.—SUTURE MATERIAL, SUMMARY

Suture material	Total	Eviscerations	Per cent
Catgut	3,970	26	0.65
Silk	1,985	12	0.60
Silk and catgut	77	0	0
Silver wire	385	5	1.29
Total	6,417	43	0.66

TABLE V.—EVISCERATION IN MALIGNANCY

	Malignant disease	Nonmalignant disease
Total cases	1,139	5,278
Eviscerations	16	27
Incidence, per cent	1.39	.51
Mortality from eviscerations, per cent	56	18.51

TABLE VI—CASES OF DISRUPTION

No. Sex Age	Diagnosis	RBC	HGB	WBC	Debility	Jaundice	Blood pressure	Arterio-sclerosis	Syphilis	Diabetes	Operation	Incision	Suture material	Cigarette drains	Disrupted P.O. days	Contributing factors	Second-ary closure	Discharged P.O. days	Died P.O. day	Follow-up	Hernia
144625 F 58	Cholecystitis, chronic	4.5	85	5,160	ø	ø	135/80	+	ø	ø	Cholecystectomy	U.R.R.	Cg	1	7	1. Pneumonia 2. Cough 3. Infected wound	Sw	30			
84624 M 47	Cholecystitis, chronic		107	5,300	o	o	168/92	o	4+	o	Cholecystectomy	U.R.R.	Cg	1	8	1. Bronchitis 2. Cough 3. Infection	Sw	23		18 mos. later	None
222786 F 33	Cholecystitis, chronic	4.8	95	8,000	o	o	122/92	o	o	o	Cholecystectomy Repair of incisional hernia	U.R.R.	Cg	1	8	1. Wound infection 2. Cough 3. Distention	Sw	31		6 mos. later	None
153948 M 37	Cholecystitis, chronic Common duct stone	5.1	102	9,600	o	+	175/105	o	o	o	Cholecystectomy Choledochotomy	U.R.R.	Cg	2	30	1. Infection 2. Vomiting 3. Cough	Sw	83			
231862 M 53	Duodenal ulcer, perforated	4.8	95	12,050	o	o	110/60	o	o	o	Plication of ulcer	U.R.R.	Cg	o	8	1. Cough 2. Broken stay suture 3. 7 Pulmonary edema	Sw	29		10 mos. later	None
174003 F 8 mos.	Intussusception, large bowel	4.9	96	19,600	o	o		o	o	o	Reduction of intussusception	M.R.R.	Slk	ø	6	?	Sw	21		28 mos. later	None
209083 F 26	Appendicitis, peritonitis		102	19,900	o	o	110/68	o	o	o	Appendectomy	McBur-ney	Cg	1	8	1. Distention 2. Postoperative obstruction	Pack and adhesive strapping	65			
150204 M 6	Appendicitis, peritonitis		88	25,000	o	o	100/60	o	o	o	Incision and drainage of pelvic abscess	L.L.R.	Sw	3	8	1. Vomiting 2. Distention 3. "Too few sutures"	Pack and adhesive strapping	87		2 yrs. later	Incisional hernia
235203 M 37	Appendicitis, peritonitis	5	112	20,500	o	o	140/90	o	o	o	Appendectomy with drainage	L.R.R.	Sw	2	11	1. Sutures too tight 2. Distention 3. Bronchopneumonia	Pack and adhesive strapping	11		10 mos. later	Incisional hernia Fecal fistula
235231 M 43	Diverticulitis, peritonitis	4	58	19,800	o	o	120/70	o	o	o	Exploration colostomy	U.R.R.	Cg	o	5	1. Massive infection 2. Bronchopneumonia 3. Vomiting	Pack and adhesive strapping	116		6 mos. later	Incisional hernia
157579 M 54	Appendicitis, chronic		100	5,400	o	o	120/80	o	o	o	Appendectomy	U.R.R.	Slk	o	7	1. Cough 2. ? of fascial sutures	Sw	24		2½ yrs. later	None
163783 M 62	Carcinoma of pancreas	4	120	10,200	+	o	130/80	+	o	o	Exploration biopsy	U.R.R.	Slk	o	8	1. Distention 2. Ascites 3. Infection	Sw		16	No autopsy	
219086 M 76	Carcinoma of stomach	2.9	57	3,900	++	o	114/62	+	o	o	Posterior gastro-enterostomy Appendectomy	U.R.R.	Cg	o	7	Vomiting	Sw	44		6 mos. later Gastric resection	None
141408 M 72	Carcinoma of stomach	2.8	54	4,600	++	o	128/68	+	o	o	Anterior gastro-enterostomy	U.R.R.	Cg	o	6	1. Infection 2. Bronchopneumonia 3. Cough	Pack and adhesive strapping		9	Autopsy	
179693 M 63	Carcinoma of stomach	4.6	102	6,300	+	o	138/72	+	o	o	Gastric resection	U.R.R.	Cg	o	12	Upper respiratory infection	Sw	28		later	Incisional hernia

TABLE VI.—Continued

TABLE VI.—Continued

No. Sex Age	Diagnosis	RBC	HGB	WBC	Debility	Jaundice	Blood pressure	Arterio-sclerosis	Syphilis	Diabetes	Operation	Incision	Suture material	Cigarette drains	Disrupted P.O. days	Contributing factors	Second-ary closure	Discharged P.O. days	Died P.O. day	Follow-up	Hernia
61693 M 58	Carcinoma of stomach	4.9	102	9,850	0	0	160/100	+	0	0	Exploration biopsy	U.R.R.	Slk	0	11	1. Vomiting 2. Distention	Sw		63	No autopsy	
173219 M 54	Carcinoma of stomach	4.9	88	6,200	+	0	160/96	+	0	0	Gastric resection	U.R.R.	Cg	0	16	1. Intestinal obstruction 2. Kink in distal loop of jejunum	Sw	26		2 yrs. later	None
226505 M 64	Carcinoma of colon	4.8	96	6,400	0	0	210/110	+	0	0	Resection	L.L.R.	Cg	0	10	1. Cough 2. Distention 3. Bronchopneumonia	Sw	42		11 mos. later	Incisional hernia
130023 M 59	Carcinoma of bowel	3.9	60	11,000	+	0	120/68	+	0	0	Ileosig-moidostomy	U.L.R.	Cg	0	8	1. Hiccoughs 2. Distention 3. Peritonitis	Silk Wg.	22		Died 6 mos. later	
241545 M 57	Carcinoma of rectum	2.9	56	4,800	+	0	140/85	+	0	0	Colostomy	L.L.R.	Cg	0	5	1. Peritonitis 2. Vomiting 3. Infection	Sw	29		6 mos. later	None
157742 M 54	Carcinoma of rectum	5	92	7,200	+	0	110/60	0	0	0	Exploration	L.L.R.	Slk	0	5	1. Extensive metastases 2. Distention 3. Bronchopneumonia	Sw		2	Autopsy	

vitamins B and C, be administered before and after operation parenterally if they cannot be given by mouth.

Arteriosclerosis and hypertension, insofar as we have been able to observe, do not play any significant rôle in wound disruption. Diabetes associated with arteriosclerosis and commonly recognized as a factor in lowering resistence to infection has not accounted for a single instance of evisceration in our series. Syphilis, long emphasized in the surgical literature as being responsible for poor healing of wounds, seems to have played no part in our group. Only 2 of these patients were found to have positive Wassermann reactions.

As to their location, the 43 wound disruptions were distributed as follows: Upper right rectus, 26; lower left rectus, 6; upper left rectus, 3; lower right rectus, 3; McBurney, 2; middle right rectus, middle left rectus, and transverse umbilical each one. The upper right rectus incision is by far the one most frequently employed, aside from the McBurney, in operations upon the abdomen. Likewise, it is through this type of incision that operations on the biliary tract have been done. Upper abdominal incisions, it would seem, are more likely to be subjected to greater mechanical strain than those of the lower abdomen. In addition, there is greater likelihood of peritonitis originating in the upper abdomen to spread to the entire peritoneal cavity than when it arises in the lower quadrants where there is a tendency to localize in the pelvis. It is for this reason that gynecological surgery is associated with a low incidence of wound evisceration.

Drains were used in 15 of the 43 patients. It is our general impression that drainage of a wound properly closed does not materially increase the probability of its disruption.

The time of disruption following operation is of significance. Although most disruptions occur between the fifth and tenth day after operation, we have had them occur as early as the first and as late as the thirtieth day. The immediate factors of wound disruption continue to be those associated with upper respiratory infection and abdominal distention. Coughing and vomiting remain the two most common symptoms that appear on the charts of these patients at the time of disruption. It seems unnecessary to stress the importance of combating postoperative pulmonary complications by rebreathing with carbon dioxide, shifting position immediately after operation and doing everything possible to prevent postoperative atelectasis. Persistent vomiting may be controlled by the use of the Wangensteen

method of decompression or Miller-Abbott double lumen tube, and we recommend their use for it is believed that this has been of importance in reducing the incidence of wound evisceration.

In these 43 patients, secondary closures were accomplished as follows: 33 with silver wire, 7 with packing and adhesive strapping, 1 with silk, 1 with catgut, and 1 with silkwormgut. Packing and adhesive strapping were used on those patients who were considered too ill even to subject to a secondary closure with silver wire. One of those died and 3 later developed incisional hernias. Following the secondary closure the patients remained in the hospital from 21 to 116 days.

The mortality rate for our entire series of 43 cases is 30.2 per cent. In our first report there were 10 deaths occurring in 22 instances of wound disruption, or a mortality rate of 45.45 per cent. In our last 21 disruptions there have been 4 deaths, or a mortality rate of 19.4 per cent. The lowered mortality we attribute to early recognition of the evisceration and to the prompt secondary closure of the wound before dehiscence has taken place through its entire extent.

POINTS TO EMPHASIZE

During the past 2 years there has appeared in the surgical literature a number of articles favoring the use of silk suture material. Whipple, Jenkins, Shambaugh, Howes, and others have reported their favorable experiences with the use of this suture material. The master of "silk surgery" was Halsted and it was chiefly his accurate understanding of wound healing and his execution of a meticulous surgical technique that established its use. It may seem logical to assume that an absorbable suture material which will disappear following the healing of the wound would be preferable to one that remains in the tissues, but in clean wounds the amount of reaction about the silk sutures is minimal. It is our opinion that many of the advantages of silk suture material are based upon the meticulous type of surgery it requires rather than on the strength of the suture material. The terms "silk surgeon" and "catgut surgeon" have come to have a definite meaning to the profession. In both groups excellent results have been obtained in the suturing of an abdominal wound. It is, therefore, important in the consideration of this subject to look upon the problem in a broader sense than the literature indicates at present. We should keep in mind the general status of the patient, his nutrition, whether or not he is anemic, and the disease that has necessitated an operation as well as the structure of the parts involved in the closure of the abdominal wound. The meticulous care exercised by the surgeon in doing an operation should be paralleled by the post-operative care of that individual in order that the anatomical and physiological integrity of the abdominal wall may be re-established in as short a time as possible. When all of these factors are recognized and receive proper attention the incidence of abdominal wound disruption will be further diminished.

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FRACTURES OF THE MANDIBLE

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A COMBINATION of reasons has produced greater interest in fractures of the mandible. The number of such fractures has increased since the advent of the automobile. Today thorough roentgenographic examination reveals many fractures that formerly went unrecognized. Recently devised appliances have made available simple and practical methods of treatment which give encouragement to the novice. The general surgeon has begun to recognize that he has not done his best for the patient if he has not restored normal occlusion.

The many recent papers on fractures of the facial bones and their management disclose a striking lack of agreement in this field of surgery. The missionary work of Kazanjian has done much to bring order out of chaos. He has demonstrated the impracticability of expensive appliances which take days to construct. He has emphasized the importance of training the oral surgeon in the use of mechanical devices. He has overthrown old accepted theories by proving them wrong, to wit, direct wiring and absolute fixation. Many of the principles described herein are either his teachings or slight modifications of them.

The threat of war and the mobilization of medical units has brought before us the need for uniformity of treatment. It is obvious that many of the principles developed by Kazanjian[1] in the last war have not become popular. In civilian hospitals, for instance, we still see complete fixation of one jaw against the other, the use of complicated splints, the covering of wire ends with compound and wax and many other practices which are relics of the past. It is the purpose of this paper to outline the simplest forms of treatment which may be applied to either simple or complicated fractures of the mandible.

Anatomy. If the thickened portions at the ends of a horseshoe were longer we would have a rough model of the mandible. If these ends were hung between two slings, the outer band of each sling would represent the masseter; and the inner, the internal pterygoid. Between them they support the ramus of the mandible and act to pull the lower against the upper jaw. These two muscles are like a pair of horses attached to the wagon whipple-tree. The temporal muscles likewise pull the mandible upward. The external pterygoid acts to protrude the lower jaw.

If we combine the action of these muscles, the pull on the shorter fragment, when the fracture is at the angle, is an arc upward and forward (Fig. 1). The depressors of the jaw are attached to the anterior portions of the body. Thus we see that the posterior fragment is always pulled upward and forward, the anterior fragment downward and backward.

Directional plane of fracture. It is also of importance whether the line of fracture is from above to below, backward or forward. If in a unilateral fracture the plane of cleavage is forward, by its very nature the posterior fragment will support the larger anterior one (Fig. 2). If on the other hand, the direction is backward there is nothing to prevent the shorter fragment from being dragged upward until the mandible strikes some portion of the upper jaw (Fig. 3). Many other elements occur, such as the irregularity of the line of fracture and the position of projecting spurs, teeth in the line of fracture, or, occluding teeth. These all make the problem more complicated.

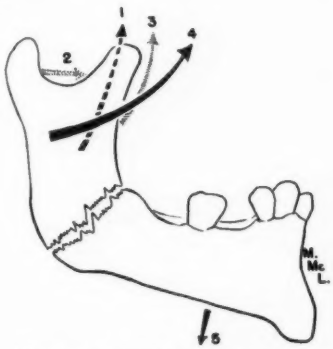

Fig. 1. Direction of muscle pull. Arrow 1, direction of pull of the masseter and internal pterygoid. Arrow 2, direction of pull of external pterygoid. Arrow 3, direction of pull of the temporal muscle. Arrow 4, direction of combined pull of all three. Arrow 5, direction of combined pull of the infrahyoid and suprahyoid groups and the digastric and the platysma.

[1]Kazanjian, V. H. Urgent treatment of face and jaw injuries. J. Am. Dental Ass., 1926, 13: 712.

From the Plastic and Dental Service of the Massachusetts General Hospital, the Dental Service of the Peter Bent Brigham Hospital, and the Oral Surgical Clinic of the Harvard Dental School.

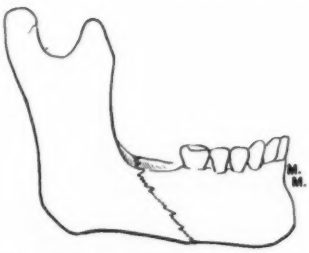

Fig. 2. The posterior fragment is being pulled in an arc upward but its direction of plane suppotrs the anterior segment.

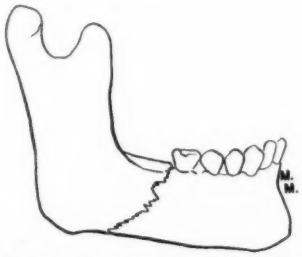

Fig. 3. The posterior fragment will be pulled upward and leaves unsupported the anterior segment.

For many years we have stressed two principles in the care of fractures of the mandible: simplicity in plan of immobilization and prompt reduction. The importance of these basic facts will be shown later. Recent papers tend to lose sight of the fact that complicated splinting causes a loss of time in reduction of the fracture which is often detrimental to the patient. They also involve a costly splint not readily available to clinic patients. The surgeon unfamiliar with the mechanism of such splints is often at a loss to apply them and disturbances of occlusion are frequently the end result.

Early reduction. One of the most important lessons which we have learned is the importance of prompt reduction and the necessity for early immobilization. It is for this reason that we illustrate (Fig. 4) a method of application of simple bandage and adhesive with elastic traction which effectively holds the mandible immobilized. This simple method, devised by Kazanjian, is in keeping with the principle that, to be effective, treatment must be simple and applicable with the smallest number of special materials and instruments.

Intermaxiliary wiring. The simplest form of fixation is intermaxillary wiring. A button serves as a hook to which intermaxillary elastics are applied. By gradual traction elastic force reduces a fracture to proper alinement and holds the segments in position. Very few special instruments are required to wire a fractured mandible. We use a 23 gauge annealed brass wire. However, many people prefer a finer gauge. For lighter gauge we use stainless steel. Thick blunt needleholders are very useful for applying the button. A pair of wire cutters such as are used by electricians are useful and also a small pair of scissors used by dentists known as crown and bridge scissors.

These buttons differ from the ordinary hook in that there are no free ends to scratch the cheeks or lips. They require no covering of wax or compound. They are sufficiently stable to withstand any amount of elastic pull without buckling. They are so shaped as to retain the elastic band without its slipping off. The strands are so uniformly twisted that there is very little danger of the wire breaking even if it becomes necessary to tighten the button at a later visit.

Intermaxillary elastics have been used for many years in orthodontia. In the latter part of the 19th century there was a bitter controversy as to the originator of the intermaxillary elastic as a corrective measure for malocclusion. There is still some debate as to whether Case or the elder Baker first described the method. The use of these elastics in the treatment of fractures of the mandible, however, owe their popularity to Kazanjian who, returning from the First World War, used and taught their use as early as 1919. A recent description in the literature adds little to what has long been known concerning the use of intermaxillary elastics.[1] It leads one to believe that the method therein described is a new method. This is incorrect, inasmuch as the principle is old, and the method has been used by many of us for two decades more or less.

Method of applying button. Figures 5 to 11 show the method of applying the intermaxillary button, with the use of a four strand brass wire, 23 gauge. The wire is passed through the interdental embrasure from the buccal to the lingual surface on the tooth and then is passed back to form a loop about a tooth which has been selected because of its strategic location and suitable shape. A second loop is likewise passed about an adjoining tooth. The wire is grasped only at its end since the scratch of the hemostat weakens it sufficiently so that breakage is liable to occur. A needleholder of the short variety grasps each of the four strands. The wire is grasped parallel to its long axis and then by traction the length of the four strands

[1] Moorehead, F. B. Better method of treating fractures of jaws. J. Am. M. Ass., 1934, 102: 1655–1657.

Fig. 4. Method of application of simple bandage and adhesive with elastic traction which effectively holds the mandible immobilized.

equalized. Grasping the four needleholders together and applying traction while the assistant supports the broken bone the needleholders are twisted simultaneously while traction is applied. It is customary to twist the wires always in the one direction, i.e., clockwise; so that should further adjustment by another operator be necessary, he may assume that the wires have been systematically twisted. While the wires are twisted that portion of wire which envelops the tooth is adjusted so that it lies at the cemento-enamel junction where there is a small depression.

As soon as the strand or rope begins to buckle under the twisting motion, the twisting ceases. The twisted strand is then cut one inch from the beginning of the twisted portion; the four ply strand is then grasped with one needleholder. With a circular sweeping motion the rope is then wrapped around to form a complete loop and then is wrapped a second time, the second loop being placed under the first thus burying the free end and preventing it from scraping the soft tissues of the cheek or lip and from cutting the elastics. The completed button is easily accessible and readily kept clean. It is firm and unyielding; its stability and ease of application makes the standardization of its application worth-while. For ordinary fractures two pairs of such buttons placed opposite each other in each premolar region, are sufficient to keep the mandible immobilized when the buttons are held together by elastics.

However, when in order to secure proper alinement it is necessary to produce traction in one direction or another and the teeth are present, this is easily accomplished by the addition of one or more buttons. In such event the button may be used as an attachment for elastics and as a guy pulley over which the elastic rides to produce force in the desired direction.

The use of elastic force presumes some experience in the practice of orthodontia. Considerable harm may result if teeth are used which are unopposed by antagonistic teeth for, although

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

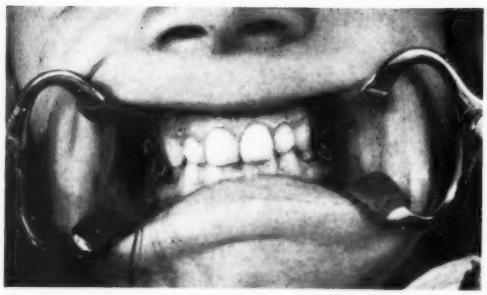

Fig. 12.

Fig. 5. The first step in intermaxillary wiring. The first loop is passed beneath the contact points of the teeth.

Fig. 6. The second loop—the wire is guided with a curved hemostat through the space between the teeth back to the buccal surface.

Fig. 7. Forming the button—each wire is grasped separately and their lengths equalized. The instruments are pulled firmly as the assistant steadies the jaw. Twisting them all clockwise simultaneously and applying traction, gives a firm, evenly wrapped strand.

Fig. 8. An instrument guides the loop on the lingual to the cemento-enamel junction. Traction ceases when the wire begins to buckle. The wire is cut one inch from the start of the strand.

Fig. 9. It is grasped again parallel to the long axis and without traction swept around in a clockwise circular motion.

Fig. 10. Completion of button—the end is buried under the button, giving it support and preventing trauma.

Fig. 11. Note the stability and ease of access of the button which is readily kept clean.

Fig. 12. The buttons are shown connected with a short elastic band.

this traction is gentle, it is continuous; and such a force is tremendous enough so that teeth can be completely lifted from their sockets in 24 hours. Should such an accident occur the wire and elastics should be promptly removed and rest will encourage the tooth to return to its original position.

In fractures of long standing where considerable deformity exists, 48 hours suffice to draw fragments, although bound down by fibrous adhesions, to their proper alinement. The one rule without exception is that no tooth or group of teeth without occluding teeth in the opposite jaw should ever be used to support a button to which elastic traction is applied.

The most important guide to proper alinement is the occlusion. However, there are several misleading factors about the meeting of the teeth of

one jaw with those of the other. The patient may have had an abnormal occlusion before the fracture, in other words he may have had a protruding or a retruding jaw. If there was protrusion of the mandibular teeth we occasionally have attempted to correct such a protrusion if this could be accomplished with benefit to the masticatory apparatus.

It sometimes occurs that after considerable effort in attempting proper reduction some space still exists between the anterior teeth. It must be remembered that pipe smokers wear teeth down so that there is often a space for the pipestem. This can be misleading.

The buttons are connected with a short elastic band which may be seen in Figure 12. In event that no elastics such as are used in orthodontia are available one may make his own short elastics. A knot may be tied in a long elastic, or bands may be cut from rubber tubing. The band need not be wrapped more than twice.

It is not necessary to fix the jaws so that it is impossible for the mouth to be opened. On the contrary, it is only necessary to hold the jaw in occlusion without force. The sudden forceful opening, as in yawning or sneezing, does no harm. We believe with Kazanjian that the ability of the patient occasionally to open the mouth a little stimulates healing. Intermaxillary elastics have other advantages. They are readily replaced without affecting the wiring or causing pain, thus permitting frequent examination of the mouth. This allows one to remove the wiring at the earliest possible moment, thus eliminating the old standard term of fixation for long periods. It also allows frequent and thorough cleaning of the oral cavity. In case a general anesthetic has to be administered, elastics need not be applied until after the patient has recovered sufficiently so as to preclude the risk of postoperative nausea. If there has been great displacement and immediate immobilization has been delayed because of complications, as in the presence of head injuries, the elastic will by its constant though gentle force reduce without trauma the fragments to proper alinement. In epileptics, who frequently fracture the mandible, the elastics are so quickly removed as to be of great value. Further, in those cases in which the wiring needs to be modified from time to time the elastic simplifies matters a great deal.

CONCLUSION

Responsibility attending the care of fractures of the mandible has increased. No longer can the general surgeon be content with union regardless of resulting occlusion; no longer can the dentist be satisfied with union regardless of the number of teeth sacrificed; no longer can the oral surgeon be content to wire the mandible for long periods of time while his patient goes on losing weight and feeling like a muzzled dog.

Properly immobilized fractures of the mandible need not be fixed for the long periods that the textbook prescribes. We have many cases which have been immobilized for less than 15 days.

The intermaxillary elastic presents a method of immobilization which is simple and inexpensive and easily applied. It has the advantage of allowing frequent inspection and cleaning of the teeth. It may be readily applied, if a general anesthetic has been given, after the patient awakens, thus avoiding the danger of nausea. It permits enough physiological movement to encourage healing. It prevents trauma to the teeth as in sudden yawning. It permits in the latter days of fixation the ingestion of semi-solid foods. While ingenuity in the application of the various devices at the disposal of the attending general or oral surgeon is not only desirable but necessary, still the practitioner who sees only occasional fractures of the mandible would do well to acquaint himself with certain standard forms of treatment for the usual forms of fractures of the mandible.

PREVENTION OF WOUND DISRUPTION WITH THROUGH-AND-THROUGH SILVER WIRE STAY SUTURES

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THE failure of abdominal wounds to heal properly and the resulting complications—wound disruption, infection, and postoperative hernia—still remain a serious problem.[1] Most recent articles on the subject are concerned primarily with the various factors influencing wound healing, such as location of the incision, the suture material used, type of operation, dietary deficiency, imbalance of blood constituents, and the presence of jaundice, malignancy, or infection, rather than with the method of closure of the wound.

We wish to describe a method of closure that has proved entirely satisfactory in preventing disruption of wounds. It consists in the use of through-and-through silver wire sutures in addition to complete closure of the wound in layers.

The patients included in this report were operated upon and followed during the past 8 years at the New York Hospital, and in all, major operative procedures were performed with the use of longitudinal rectus incisions. This study would seem to indicate that the most important single factor in evisceration is the type of closure, since separation of the wound has been avoided by the use of the closure to be described.

Needless to say, its efficiency in relation to postoperative infection and hernia depends in large part upon the strict observance of the cardinal principles of surgery: asepsis, complete hemostasis, and gentle handling of tissues. For a full discussion of additional factors influencing wound healing, other papers may be consulted (1, 6, 7, 8, 11, 13, 16, 17).

During the past 10 years several reports (2, 3, 4, 9, 12, 15) have given adequate statistical reviews on the subject of evisceration from the point of view of suture material, type of operation, and location of incision. These observers have found the incidence of wound disruption to range from 1 to 3 per cent, with a mortality varying from 28 to 50 per cent, in spite of the various types of wound closure. However, Kennedy (10) in 1928 reported very satisfactory results with a through-and-through closure in which silkworm gut was used. Likewise, Reid, Zinninger and Merrell, (14) in 1933, reported a method of abdominal closure with through-and-through silver wire and demonstrated that this closure was of particular value in patients who had serious intra-abdominal traumatic injuries. In their hands there was no instance of evisceration in the 334 cases operated upon. However, there are two technical objections to this simple through-and-through closure. One is the tendency for the wires to be closed so tightly that, with the development of postoperative edema of the wound, the wires cut into the tissues and the subsequent pressure necrosis causes pain and a high incidence of infection. Second, it is impossible to approximate the various layers accurately, and, therefore, the incidence of postoperative hernia is high. In an effort to eliminate these objections a modification in the technique has been introduced, i.e., the closure of the wound in layers, in addition to the use of through-and-through silver wires. Undoubtedly, this closure has been used from time to time in various clinics, but it has not received enough emphasis to be accepted as a routine in certain types of patients. This closure should not, of course, be used in all types of cases; rather, its use should depend upon the operation and the pathology, and the age and condition of the patient. Since through-and-through silver wire with closure in layers requires more time, it cannot entirely replace simple through-and-through closure in those patients in whom rapid closure is necessary. Likewise, the latter is the ideal method for repair of disrupted wounds.

Following is a description of the type of closure advocated. As shown in Figure 1, the silver wires (20 gauge) are inserted straight through all layers of the abdominal wall, including peritoneum, about 1 inch from the skin edge and placed about 1¼ inches apart. An atraumatic needle is used in order that the silver wire can be introduced easily and without injury to the tissue. If such a needle is not available, a large cutting-edge needle similar to that used for inserting tension sutures may be used if the short end of the silver wire is turned back and crushed together where it passes through the eye of the needle. Following the in-

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[1]Wounds in which all layers separated, including peritoneum, with or without evisceration, were considered as disrupted wounds.

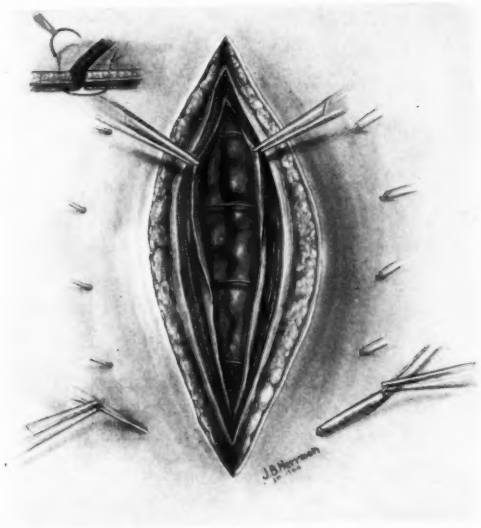

Fig. 1.

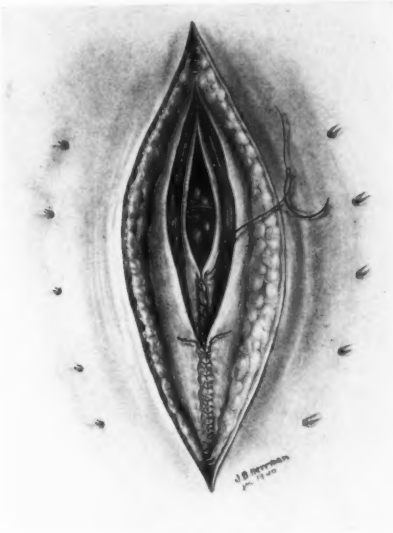

Fig. 2.

Fig. 3.

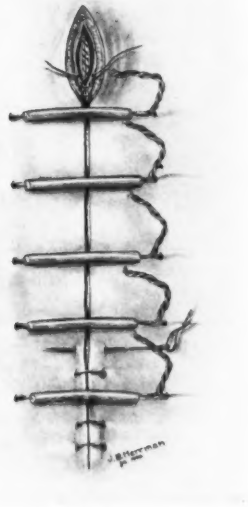

Fig. 4.

sertion of the silver wires, the peritoneum is closed with a continuous suture of catgut for a distance of about one-half to three-fourths of the wound, and then the fascia is approximated for a somewhat smaller distance. (Fig. 2.)

As shown in Figure 3, the silver wires for that portion of the wound that has already been closed are then twisted down in place. It is important that the operator place his finger within the abdomen when the wires are being twisted down to prevent omentum or viscera from being caught between the silver wires and the peritoneum, and the wires should be twisted 6 to 8 times to prevent their opening. With the exception of the

TABLE I.—TYPE OF CLOSURE

Type of closure	Total cases	Wound infections		Post-operative hernia		*Wound disruption	
		No.	%	No.	%	No.	%
Through and through with closure in layers	104	11	10.00	5	4.80	0	0
Simple through and through without closure in layers	108	37	30.40	18	16.60	2	1.85

*Since this report includes only those patients who recovered from their operations and were followed after operation, patients are excluded who died or who were lost to follow-up examinations. Glenn and Moore (5) have reviewed all eviscerations occurring in New York Hospital. Their percentage of eviscerations for (1) through and through with closure 0 per cent; (2) simple through and through 1.2 per cent.

upper inch, the remaining part of the wound is then closed in layers, and, with the upper end of the wound still open, the remaining silver wires are twisted down in place. The upper part of the wound must be kept open until all the wires are twisted in place, so that the operator can keep one finger in the abdomen to prevent strangulation of the viscera between the silver wire and the peritoneum. After twisting down all the silver wires, the small remaining portion of the open wound is closed in layers, and the skin is approximated with interrupted fine silk sutures.

The most important feature of this closure is that the silver wires should not be closed too tightly. It should be possible to place one finger easily between the silver wires and the skin after the wires are in place. Small caliber suture material (chromic catgut No. 0 or silk) is preferred for the layer closure so as to reduce the amount of foreign body in the wound. Rubber guards for the silver wire may or may not be used. In the absence of infection, the wires may be removed safely on the fourteenth to sixteenth day, whereas, in simple through-and-through-closure, the wires should not be removed until the twentieth to twenty-first day. After the use of any variety of through-and-through closure the complication of extension of infection from the wound into the peritoneal cavity has never been observed. There has been no wound disruption and, with the exception of silk closure, the incidence of postoperative infection and hernia is considerably less than in any other type of closure. (Table I.)

It will be seen from Table II that the cases in which the two methods of closure were used were similar.

In clean cases—exploratory laparotomy, cholecystectomy for chronic cholecystitis—in which the laparotomy wound was closed with silk, wound disruption, infection, and postoperative hernia occurred in less than 1 per cent. In a similar group of cases in which the laparotomy wound

TABLE II.—CONDITIONS FOR WHICH OPERATION WAS DONE

	Through and through with closure in layers		Simple through and through without closure in layers	
	No.	%	No.	%
Perforated peptic ulcer	2	2	8	7
Gastric resection	29	30	12	11
Secondary gastric resection	7	6	8	7
Posterior gastro-enterostomy	7	6	13	12
Choledochotomy	12	12	8	7
Cholecystectomy	18	18	25	24
Bowel resection	16	16	15	14
Exploratory laparotomy	4	3	9	9
Miscellaneous	9	7	10	9
	104		108	

was closed with catgut, wound disruption occurred in 2 per cent, infection occurred in 10 per cent, and postoperative hernia in 9 per cent. This comparison emphasizes the advantage of a silk closure of the clean wound when the closure is done by those familiar with silk technique.

CONCLUSIONS

It is not advocated that the closure described should replace all other types, particularly silk, but it can be used to great advantage in certain patients.

Its advantages are: (1) a secure closure without fear of evisceration; (2) elimination of the objections to simple through-and-through closure, with the results that the patient does not suffer from a painful wound, that the incidence of infection and postoperative hernia is greatly reduced, and that a satisfactory scar is obtained.

It is an ideal closure for (1) all patients on whom the gastro-intestinal tract has been opened; (2) patients in whom there is acute intra-abdominal infection; (3) patients who are old and debilitated whom it might be advantageous to get up at an early postoperative date; (4) patients who for one reason or another may have a delayed wound healing, with the possibility of wound disruption.

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THE USE OF ALLOY STEEL WIRE IN THE CLOSURE OF ABDOMINAL WOUNDS

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SINCE the introduction of alloy steel wire by Babcock (1, 2), this material has been employed with increasing frequency at the Cleveland Clinic for the closure of abdominal wounds. The incidence of abdominal wound morbidity has been reduced to such an extent that we believe a further report of its use would be of interest. A technique of closure with alloy steel wire is presented, and the incidence of wound infection and disruption is contrasted with antecedent methods and materials.

The use of wire sutures in the closure of abdominal wounds is not of recent origin. Historical reviews have been presented by Kraissl in 1936, and by Kaufman, Johnson, and Lesser in 1939. Following the first reports of Babcock, a number of articles appeared in the literature describing the advantages of alloy steel wire sutures. Dambrin closed the abdomen in two layers, the first including all planes except the skin and subcutaneous tissues which were included in the second. In his experience, the advantages of alloy steel wire were: (1) It was tolerated well by the tissues, (2) it could be used in the presence of infection, and (3) it produced solid closure and eviscerations were rare. Complaints of discomfort from wire knots were infrequent. It was occasionally necessary to remove a suture which acted as a nidus for a draining sinus.

Welti closed the peritoneum and posterior fascia with catgut and the anterior fascia with interrupted alloy steel sutures. Genkins, in reviewing the experience of Babcock, stated that a larger percentage of wounds healed by first intention and that alloy steel was the most satisfactory suture material for use in infected fields because there was no tendency to sinus formation. Kaufman, Johnson, and Lesser found that the incidence of wound infection in the repair of hernias was markedly reduced when alloy steel wire was used. Preston showed that the tensile strength of wounds sutured with alloy steel wire was greater than that of those closed with silk or catgut. Several cases were reported demonstrating the absence of a tendency to produce draining sinuses in the presence of an infected field.

From the Cleveland Clinic.

One of the first clinical impressions of alloy steel wire used alone without stay sutures in the closure of abdominal wounds was the frequency of satisfactory healing, regardless of such adverse factors as carcinomatosis, deep jaundice, and general cachexia. Disruption was rare, despite the fact that wire was used in all of the more severe abdominal operations when this accident was feared. Wound infection seemed to be reduced markedly.

In order to confirm or deny this satisfactory clinical appraisal of wire sutured wounds, separate studies were made to compare the incidence of wound disruption and infection with other methods of abdominal closure.

Wound disruption. From January 1, 1930, to January 1, 1940, a group of surgeons at the Cleveland Clinic performed 4,154 consecutive laparotomies with 44 disruptions, an incidence of 1.05 per cent. This compares favorably with most of the reports in the literature (3, 8, 9). Fifteen deaths in the 44 cases were attributable to disruption, a mortality rate of 34 per cent. The mortality rate from this accident is quoted in the literature from 8 to 53 per cent (3, 6, 8, 9).

A detailed study of these 44 cases revealed that more than half of the disruptions occurred in upper rectus incisions, and that the highest incidence was found in operations on the biliary tract. This is in accordance with the findings in the series reported by Meleney and Howes. The disruptions according to the locations of the incisions were as follows: upper rectus, 23; lower rectus, 7; upper midline, 6; lower midline, 5; other locations, 3; a total of 44.

Although it was difficult to obtain accurate information regarding the predisposing causes, abdominal distention with vomiting occurred to a fairly severe degree in 30 to 40 per cent of the cases. Wound infection and drainage of bile and pancreatic juices was the second major cause, and was found in 20 per cent. Because of the rapid digestion of the catgut, biliary and pancreatic drainage are probably of paramount importance in disruption of wounds closed with catgut, as compared to those closed with nonabsorbable sutures.

In view of the high incidence of disruption in upper rectus incisions, especially in those made for operations on the biliary tract, a consecutive series from January 1, 1937, to January 1, 1940, was selected for a comparative study of wound disruption with various types of closure and suture materials. In this period, 193 operations were performed by members of the surgical staff, with 11 disruptions, an incidence of 5.7 per cent. Of 54 wounds closed in layers with catgut alone, either continuous or interrupted sutures, 6, or 11 per cent, disrupted. In 58 cases the wounds were sutured with continuous catgut sutures to the peritoneum and posterior rectus fascia, and with interrupted alloy steel wire to the anterior rectus fascia. In this group 4, or 6 per cent, of the wounds disrupted. Buried interrupted figure-of-eight alloy steel sutures were used to close 81 wounds. No stay sutures were used. Only one disruption occurred with this type of closure, an incidence of 1.2 per cent (Table I). The fact that nearly all the severe cases with jaundice and malignancy of the head of the pancreas were found in the last group adds significance to the results.

TABLE I.—ABDOMINAL WOUND DISRUPTION I OPERATIONS ON THE BILIARY TRACT[1]

Suture material	No. cases	No. disruptions	Per cent
Catgut (all layers)	54	6	11.0
Catgut and alloy steel wire	58	4	6.9
Alloy steel figure-of-eight sutures, no stay sutures	81	1	1.2

[1]Comparison of Suture Material in 193 Consecutive Cases January 1937, to January, 1940.

Wound infection. The total experience with abdominal wound healing in combined abdominoperineal resections for carcinoma of the rectum done by one surgeon (T. E. J.) was reviewed, and the morbidity in various types of closure of the abdominal wound was compared. This operation was selected for study because of the high incidence of infection in wounds closed with catgut and supporting stay sutures.

In order that a strictly comparable series could be obtained, 256 consecutive cases fulfilling the following requirements were taken from a total series of 366 cases: (1) The operation was a one stage combined abdominoperineal resection, (2) the colostomy was brought out of the abdomen through a midline incision, and (3) the technique of the operation was the same. Two stage resections, inguinal colostomies, preliminary cecostomies, and cases in which death occurred, except those attributable to wound morbidity, were excluded.

This series classified itself, in chronological sequence, into 3 groups. In Group I (76 cases), the abdominal wound was closed in layers with catgut and reinforced with silkworm gut stay sutures. In Group II (64 cases), the peritoneum and posterior rectus fascia were closed with catgut and the anterior rectus sheath, with interrupted alloy steel sutures. Stay sutures were not used. In Group III (116 cases), the abdomen was closed with alloy steel figure-of-eight sutures alone, including all layers except the skin and subcutaneous tissues. Stay sutures were not used. In all of the groups the hemostatic ligature was fine No. 000 chromic catgut. The skin was closed with clips. No sutures were used in the subcutaneous tissues, even in obese patients.

Wound infections were clinically classified as slight, moderate, and severe. A small localized subcutaneous infection was considered slight. Definite abscesses superficial or deep to the anterior rectus fascia, but which healed before the normally expected hospital discharge, were classified as moderate. Infections which seriously endangered the life of the patient or prolonged hospitalization, or those to which death was attributable, were classified as severe.

As shown in Table II, in Group I, 27.5 per cent of the wounds became infected. Disruption occurred in 3 wounds, or 3.9 per cent, once because

TABLE II.—ABDOMINAL WOUND MORBIDITY IN ONE STAGE COMBINED ABDOMINOPERINEAL RESECTIONS[1]

Group	Type of closure	Infections					Disruptions	
		No. Cases	Slight	Moderate	Severe	Per cent	No. cases	Per cent
I	Catgut in layers with stay sutures	76	3	17	3	27.5	3	3.9
II	Catgut and alloy steel. No stay sutures	64	0	7	2	14.0	0	0.0
III	Alloy steel figure-of-eight sutures. No stay sutures	116	0	1	0	0.85	0	0.0

[1]A Comparison of Types of Wound Closure in 256 Cases.

Fig. 1.

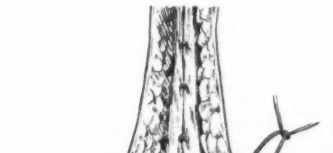

Fig. 2.

Fig. 3.

of infection and twice in the presence of apparent clean healing. Two of these patients died of peritonitis as a result of the disruption. In Group II, infection developed in 14 per cent of the wounds. There were no disruptions. In Group III, only 1 wound infection occurred, an incidence of 0.85 per cent. This occurred in the seventh case of the group. In the last 109 consecutive one stage abdominoperineal resections for carcinoma of the rectum, with midline colostomies and closed with alloy steel figure-of-eight sutures, there has not been a single infected wound.

No strictly comparable figures on the incidence of hernia in the 3 groups can be quoted, since the follow-up in Group III has not been of sufficient length of time, but we have yet to see a hernia or weakness of the wound about the colostomy where wire figure-of-eight sutures were used.

TECHNIQUE

A method of closure of abdominal wounds with alloy steel wire employing Smead's stitch,[1] is shown in the accompanying diagrams. A figure-of-eight suture passes first through anterior fascia, muscle, posterior fascia, and peritoneum (Fig. 1a), and again through the anterior fascia in the same direction (Fig. 1b). After three-fourths of the wound is closed, the remaining fourth is "loaded" with the first part of the interrupted stitch (Fig. 2). Each suture is then completed in turn.

The wire ends are cut flush with the jaws of a hemostat which is clamped snugly against the knot (Fig. 3a). The hemostat is then rotated 180 degrees, turning the ends downward (Fig. 3b). A smooth knot is thus presented to the subcutaneous tissues, in which no sutures are placed. The skin is closed with metal clips.

Certain technical details in regard to the type of suture and the handling of the wire itself must be adhered to: (1) The proper amount of tension must be exerted in tying the suture to approximate, but not constrict, the tissues; (2) the knot must be square; (3) the ends of the wire must be turned down carefully; (4) kinking must be avoided since the wire will break at this point. Wire "handles" differently from silk or catgut but, with experience, it may be used with equal facility.

As the figure-of-eight sutures are pulled taut, each plane of the wound is well approximated. No more accurate closure can be accomplished by sutures in layers. Digital palpation of the peritoneum shows a perfectly smooth wound surface.

[1]This stitch was devised by Dr. Louis Smead, of Toledo, Ohio, during his residency in surgery under Dr. John Finney, Sr. of Baltimore. We have been advised by personal communication that a description of its use has not been published by him.

ADVANTAGES AND DISADVANTAGES

During the past 3½ years, alloy steel wire alone has been chosen with increasing frequency for the closure of abdominal wounds by the members of the surgical staff of the Cleveland Clinic. It is now used extensively in operations on the biliary tract, for benign lesions of the stomach and duodenum, and routinely in operations for gastro-intestinal and other abdominal malignancies in both the upper and lower abdomen.

The routine use in gastro-intestinal malignancies deserves note. The marked decrease in wound complications has been a major factor in the reduction of postoperative morbidity and hospital mortality. The series of combined abdominoperineal resections presented typifies the entire experience.

Most clean laparotomy wounds can be closed satisfactorily with catgut, silk, or cotton. However, when actual or potential wound infection exists, or when disruption is feared, we believe that better results can be obtained with steel wire. Steel-closed wounds heal with very little tissue reaction to the suture material. In this respect steel is similar to silk, but it has an added advantage in that the production of chronic draining sinuses is rare, even in the presence of a grossly infected field. The induration and grayish, necrotic foci about catgut is in sharp contrast to the clean, reactionless healing in the presence of wire.

The disadvantages of steel wire are few. Rarely, a suture will perpetuate a draining sinus. It has been necessary to remove sutures for this reason in only 2 instances. Occasionally, a patient with scanty subcutaneous tissue will complain of discomfort about a knot but it is a simple procedure to locate and remove the offending suture under local anesthesia.

We believe that alloy steel wire is indispensable in operations for gastro-intestinal malignancies, and so advantageous in many other procedures that its few disadvantages are greatly outweighed.

SUMMARY

1. The use of buried alloy steel sutures alone without stay sutures for the closure of abdominal wounds has reduced wound morbidity to an extremely low incidence.

2. The incidence of wound disruption in operations on the biliary tract has been reduced from 11 per cent in closures with catgut to 1.2 per cent in wounds closed with alloy steel figure-of-eight sutures alone.

3. The incidence of infection in abdominal wounds in combined abdominoperineal resections with midline colostomies has been reduced from 27.5 per cent with the use of catgut in layers and stay sutures to 0.85 per cent with the use of interrupted figure-of-eight alloy steel sutures.

4. A method of closing abdominal wounds with wire is presented.

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ACUTE AND CHRONIC INTRA-ABDOMINAL LYMPHADENOPATHY

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LYMPHADENOPATHIES of one kind or another are well known to the profession in regional areas of the body other than the mesenteric area where their secluded position has served until recently to prevent sufficient examination and study. It appears that the adenopathies of the abdominal field are identical with those of other regions of the body; that the lesion may be acute or chronic and of varying degrees of intensity; that some lymphadenopathies in the mesenteric area are of maximum grade while others, the great majority of the instances, are apparently simple and more benign cases of mesenteric adenitis. It is the last group that we have especially under discussion. In some types the etiology is well known; in others it is still under discussion, and to these the term "nonspecific" has been applied.

The term "nonspecific" as used in this communication is intended to convey the thought that the essential cause of the glandular enlargement under discussion was not specifically known at the present writing or that the adenitis had a potential multiple form of etiology. The term might be better paraphrased as "nonclassifiable." Except as an incidental matter unavoidably provoked by the discussion of nonspecific mesenteric adenitis, there will be no reference, therefore, to specific forms of lymphadenopathy—due either to a specific infecting agent such as those causing typhoid, tuberculous, luetic, or other disease, or to neoplastic change such as the forms of lymphosarcoma, or those bordering upon inflammatory or neoplastic disease such as Hodgkin's disease.

A previous communication summarized all available knowledge concerning the anatomy and physiology of the intra-abdominal lymph nodes, including the usual type of structural arrangement and its "normal variations." The normal functional processes (physiology) and the effects upon the latter of age, nutrition, environment, growth, etc., and of certain abnormal conditions of the body such as fever, anemia, etc., were all gone into exhaustively. It does not seem necessary to repeat this factual knowledge, and those interested sufficiently are referred to the original paper or to the standard works on anatomy and physiology.

It seems important, however, to comment again upon the variable size of the nodes when distinguishing between normal and abnormally enlarged glands; and this factor is especially important in the long standing, chronic conditions. It seems that there are as yet no certain measures of the normal variation in size of the mesenteric and other lymph glands and that the lymphatic tissue and glands may be considerably more developed than have hitherto been assumed. In the previous study I pointed out the possibility that in many of the published cases the size of many of the observed intra-abdominal glands may have possibly been within normal limits; and that, as a consequence, fundamental errors of diagnosis were possible in reference to any observed symptomatology in such lymph nodes.

A constant variable physiological fluctuation during the different phases of life occurs in the midst of relatively healthy periods; it is a nonspecific phenomenon common to very many diseases. For instance, fever has an effect on the lymph nodes which is characterized by decreasing the delivery phenomena of the lymph nodes into the peripheral circulation. This has recently been studied by Doan. Unless the period of sustained fever is unduly prolonged increased circulation and regeneration occurs fairly quickly and this can be measured in terms of the leucocytosis which follows.

The superlatively developed absorption function of the intestinal tract combined with the constant presence of bacteria in the intestinal lumen creates a situation in which the passage of bacteria from the bowel interior into the associated lymphatic vessels and glands must be considered an almost "normal" and "physiological" phenomenon. Although manifestations of the reaction of the host's defense mechanism against this continuous onslought of bacteria (i.e., disease) are not apparent, it must be true that lymphatic enlargement will take place and in certain instances persist. In the ordinary stress of health and disease and under the proper circumstances, this fact would tend to complicate attempts at integration of the presence of mesenteric nodes into a given syndrome in which other pathology is not demonstrable.

ACUTE INTRA-ABDOMINAL AND/OR MESENTERIC NONSPECIFIC LYMPHADENITIS

An acute abdominal condition of variable grade exists in children and young adolescents. It is similar in its general manifestations to that of appendicitis, diverticulitis, etc., but in such instances the only discoverable finding at operation is an enlargement of the mesenteric and retroperitoneal lymph glands in the ileocecal angle. The condition appears to be more common than is thought (Struthers, Freeman, Heusser, Wilensky, etc.), and in the series collected by Short it was found to occur in 6 per cent of 200 cases. The cases of this description usually come under the direct observation of the pediatrician and the surgeon.

The general clinical facts manifested by these cases are as follows:

The patient is usually between 3 and 18 years of age (Wilensky, Short, Freeman, Struthers, etc.) but in some of the reports patients have been young adults, and in the series of 200 cases collected by Heusser, Guleke, and Sennels, the age incidence fell chiefly between 10 and 20 years. In a typical attack the patient is seized with abdominal pain of varying severity generally located in the lower right side of the abdomen, occasionally extending over to the left side. The abdominal symptoms are not as distinct as in appendicitis, or in some other acute intra-abdominal condition. In the simple cases, there is an absence of the signs usually seen with a perforation, and no generally toxic symptoms exist; but sometimes there are general toxic symptoms out of proportion to the relatively insignificant local symptoms. In other somewhat uncommon cases, however, the local clinical picture is more profound. This is also true when complications occur. In either of these instances, the local lesion confirms the clinical picture presented.

The attacks subside as a rule. In some there is only one attack; in others the attacks recur at intervals of weeks or months. During the intervening periods the child is apparently well. In some the attacks will continue to recur until, under the diagnosis of "chronic appendicitis," an appendicectomy is done. In some such cases there will be freedom from symptoms thereafter, but in others the attacks still persist. In the latter group, definite knowledge as to the cause of the abdominal pain still is lacking or the pain persists even when the apparent or discoverable source of infection has healed. In other words, it is possible that pain will remain after the removal of an appendix which shows pathological evidences of disease.

In spite of the fact that mesenteric lymphadenitis is always secondary, the clinical symptoms which it presents would suggest an apparently independent complete picture in which sometimes the source of infection is veiled or at times difficult or impossible to locate. Thus mesenteric lymphadenitis is sometimes the first concrete evidence of intra-abdominal disease.

This form of mesenteric adenitis must be differentiated from the acute abdominal conditions common to children and adolescents, such as appendicitis, Meckel's diverticulitis, intussusception, etc., possibly from influenza and from some other forms of infectious gastrointestinal disease. Inasmuch as the clinical picture and the available laboratory aids are not specific, the differentiation is always difficult and very frequently impossible. One is impelled by anxiety to make a correct differentiation, and commonly one is compelled to do an abdominal exploratory operation in order to establish the true condition of affairs.

CHRONIC INTRA-ABDOMINAL AND/OR MESENTERIC NONSPECIFIC LYMPHADENITIS

The term "chronic" refers to a clinical syndrome affecting the interior of the abdominal cavity which has lasted a relatively long time, or which has occurred as a succession of episodes interrupted by periods of lesser intensity, perhaps at times almost completely disappearing. The appearance of such episodes must under such definition be interpreted as "acute" or "subacute" exacerbations of the underlying cause of the abdominal pain. In actual clinical practice this is the commonest course of events, following an initial "acute" attack.

With this form of "chronic" abdominal disease patients complain of vague, diffuse intermittent, transitory attacks of colicky, drawing or dragging pain usually in the right lower quadrant of the abdomen commonly associated with anorexia, with repeated attacks of indefinite gastric distress associated with nausea and vomiting, with loss of weight, and with slight fever. The pain may vary from a dull grumbling discomfort, usually in the right lower quadrant, to attacks so violent that surgical intervention is considered. Constipation and diarrhea are not common symptoms in the chronic form but may be present in the characteristic acute exacerbations. According to Alvarez, in some a subacute form of arthritis finally follows. The symptoms occur similarly in older children and in young adults and more commonly in the female sex.

In the vast majority of these cases the patients are children and of the female sex, so that these

factors may be accepted as more or less characteristic of this affection. It is difficult to say how frequent is this form of chronic lymphadenitis. In Foster's series of cases in which he has grouped acute and chronic cases, it seems remarkable that the percentage for the chronic cases is 64 as opposed to 8 per cent for the acute cases. My own experience is not large.

In the more advanced cases and in the group of older patients there is a tendency toward marked mimicry of other known symptom complexes; there may be symptoms of dysphagia (Wakely); or symptoms suggestive of peptic ulcer (Thiemann, Lund, Bier, Keppler and Erkes, Davidovitch, Ljunggren, Golden and Reeves), of biliary colic, (Most, Pribram), of intestinal spasm (Schalij), of constipation or diarrhea (Sternberg), of renal colic or hematuria (Schmieden, Walker, Davidovitch, Golden and Reeves), or even of sciatica (Ljunggren). The commonest complex imitates very closely that which we customarily have known as "chronic appendicitis."

In this type of syndrome, more and more commonly as attention is being constantly focused on it, enlarged glands are the sole findings at abdominal explorations either performed frankly as such or done under mistaken diagnoses. Occasionally such glands are sufficiently large to be palpable before operation.

The differential diagnosis has commonly been most difficult in the chronic cases. Many factors must be considered, a general survey of which are:

1. There are certain abdominal manifestations common in adults and practically unknown in infancy and early childhood, such as those of chronic gastritis, of ulcer and carcinoma of the stomach, of biliary colic, of gastric crises in tabes dorsalis, of movable kidney. Appendicitis is apparently very rare in the first and even the second year.

2. There are some abdominal syndromes that have the same significance and show the same characteristics at all ages, except perhaps in young children, such as salpingitis, appendicitis, and renal colic.

3. Other abdominal manifestations occur wholly or predominantly in infancy or in early childhood. Nearly all of those occurring in infancy are produced by obstruction of a hollow viscus—pyloric stenosis, intussusception—or are associated with digestive abnormalities—colic. Later abdominal pain occurs with throat infections and with pneumonia; but this is relatively acute. Chronic abdominal pain occurs with tuberculous spondylitis, with the chronic nonappendiceal forms of peritonitis, with tuberculous peritonitis, with rheumatism and Henoch's purpura, with the occasional case of worms, *and lastly with enlarged inflamed mesenteric and retroperitoneal glands.*

With modern methods and with adequate laboratory aid, it should not be difficult to make a differential diagnosis between urological, gall bladder, stomach, and female pelvic disease. Cases of *bona fide* acute appendicitis in the vast majority of the cases should not escape one. In subacute and chronic cases of "appendicitis," however, the difficulties are great. The situation in regard to appendicitis may be summed up as follows:

a. The group in which delayed operation invariably resulted in cure. On these appendicectomy was not done in the acute stage of the various forms of a *bona fide* acute appendicitis. The symptoms continued for a variable length of time until a chronic phase was reached and the appendix was then removed. In such a case the usual condition found was a chronic abscess or a chronic hypertrophic appendicitis; in some cases the lesion resembled a nonspecific granuloma of the intestine.

b. A small group in which the pain resembled that of gastric and duodenal ulcer but was referred to the appendix despite the fact that no pathological lesion could be demonstrated therein. In almost countless experiences this has been proved to be a delusion; the pain has no demonstrable relation to the appendix or to the stomach and duodenum, it has no other demonstrable basis, and in practice such a pain is most difficult to handle as it does not react to any therapeutic agent employed.

c. A group in which appendicectomy and other forms of therapy failed to relieve episodes of pain or continuous annoying sticking pains in the right side of the abdomen, the symptoms simulating no well known complex.

In later years it has seemed to be more and more true that many, if not all of the patients in groups b and c, had some form of psychoneurotic basis or background for the clinical picture. This conclusion was frequently confirmed by the presence of corneal and pharyngeal anesthesia and by excessive activity of the knee and other tendon reflexes.

d. A large group in which an "obliterated" appendix had previously been removed. Commonly removal was associated with a somewhat hypertrophic change in the terminal nerves of the appendix, which was labeled a "neuroma." Recurrence of symptoms was almost the rule and I am convinced that such anatomical changes are of a regressive involutionary character and cannot produce abdominal pain.

The differentiation between acute and chronic cases is sometimes more or less of an artefact, because at times the chronic cases are simply those in which a succession of acute episodes has taken place separated by intervals in which the symptomatology is less intense or in which it has simmered down even to the point where the symptoms are tolerated so completely as to make the patient believe they have disappeared entirely. In either case the chronic anatomical changes eventually characterize the pathological picture. This probably accounts for the peculiar percentage figures in Foster's series.

ROENTGENOLOGY

Commonly roentgenographic study of the abdominal viscera—gastro-intestinal series, etc.—shows no abnormality.

Under the usual normal conditions, roentgenographic observation shows that the stomach empties continuously and barium passes steadily in the normal direction, reaching the cecum in 1½ to 4 hours. Each successive film shows progress distally in the position of the head of the barium column. The segmental peristaltic movements flow smoothly and are promptly followed by normal flexible relaxation of the intestinal wall. If there is no delay in movement, the ileum should be empty in 9 hours. The barium mass in the normal small intestine is usually continuous, that is, not broken up into separate small oval boluses. The width of normal, barium-filled loops varies from 1.5 to 3.0 centimeters, and is usually 2.0 to 2.5 centimeters.

In association with acute symptoms Golden and Reeves observed the following manifestations of disturbed small intestinal physiology: "(1) localized spasm, i.e., narrowing of a small segment adjacent to the calcified node, either temporary following a peristaltic wave or persistent; (2) persistent generalized spasm of a group of small intestinal loops in the region of the diseased nodes; (3) delay in the passage of barium at the site of the calcified node; (4) delay in the emptying of the ileum for periods of over nine hours." In both the acute and chronic cases calcifications are sometimes visible roentgenographically. In the acute cases the coincidence is usually disregarded. In the chronic cases they are differently considered.

Golden and Reeves point out "the possibility that the roentgenographically observed disturbance of physiology in the intestine may be an explanation for the symptoms often associated with calcified mensenteric lymph nodes. The disturbances in small intestinal physiology include spasm and seemed to take place in loops of intestine directly adjacent to calcified nodes." A questioning attitude concerning the relationship of roentgenographically demonstrated calcified abdominal lymph nodes and the symptom complex which an individual patient presents is necessary. This questioning attitude is advisable because it is not necessarily so that the one is responsible for the other.

ETIOLOGY OF INTRA-ABDOMINAL AND MESENTERIC LYMPHADENITIS

Specific forms of intra-abdominal and mesenteric lymphadenopathy are commonly parts of distinct clinical complexes such as typhoid fever, dysentery, etc. The protean nature of the etiological factors concerned in nonspecific forms of lymphadenopathy within the abdomen is well shown by their relatively enormous distribution. Some are related to loosely gathered clinical entities known collectively as the "rheumatic" group. Still others are related to various groups associated with generalized cutaneous manifestations including some of the exanthemas. A large group seems to be related to a preceding "catarrhal" or "throat" infection; and this seems to have some relationship to forms of glandular fever and infectious mononucleosis and to what is clinically known as abdominal grippe. Finally there is a group in which the lymphadenopathy cannot be clinically connected with any demonstrable preceding or accompanying lesion. Because of the latter fact the cases in the latter group have been associated in a still undemarcated and undifferentiated classification and are for want of a better nomenclature called nonspecific mesenteric adenitis.

Not always is the causative agent demonstrable in nonspecific mesenteric adenitis. In only a minority of the latter cases bacteria can be demonstrated in the glands, and the predominating organism is some strain of streptococcus. Occasionally other bizarre organisms can be cultured such as Bacillus melitensis. An unidentified virus has also been suggested as the causative agent; but the correlation of this virus with that which might cause poliomyelitis has not been proved. No relationship can be demonstrated by the Frei test with lymphogranuloma venereum. Various parasites have been found to occur in the intra-abdominal lymph nodes: a causal relation cannot be established between them and acute nonspecific mesenteric adenitis; but in chronic mesenteric adenitis there might be some etiological connection in that the parasites might be intermediate factors in introducing other forms of bacterial infection.

PORTAL OF ENTRY OF THE CAUSAL AGENT

The portal of entry for the causative agent of nonspecific mesenteric adenitis is only on rare occasions the appendix; and this can happen only because of some anatomical abnormality of the lymphatic drainage pathways of the appendix. More commonly the portal of entry seems to be related to "catarrhal" or "throat" infections and then nonspecific mesenteric adenitis is least commonly a manifestation of a hematogenous mechanism or more commonly the causative agent is swallowed from the oropharynx and passed along to the terminal ileum from which local absorption occurs. Most frequent of all the nonspecific mesenteric adenitis is a local absorption effect from some local nondemonstrable lesion in the ileal segment of the alimentary canal; it can be safely assumed that this includes various forms of transient enteritis and other surface infections, various gross and microscopic injuries, and other forms of physical and chemical trauma.

In this most common mechanism the similarity to the ordinarily observed phenomena in cervical adenitis is absolute. In either case local injuries and infections permit the passage of the causative agent to the appropriate lymph nodes. The mechanism is based upon an exact duplication in either position of the anatomical arrangement of the local lymphadenoid tissue in the wall of the alimentary canal and of the corresponding lymph nodes. And the heaping up of extraordinary collections of lymphadenoid tissue in the wall of the alimentary canal at either of these locations is remarkable and seems important from an etiological and mechanistic viewpoint.

I wish to emphasize the importance of the terminal ileum as a regional portal of entry for the causal agent for many and perhaps most of the cases of simple nonspecific mesenteric adenitis. The opportunities for absorption of any causal agent are remarkable including that associated with the normal digestive functions and that predicated upon the occurrence of local points of injury. The passage of any provocative causal agent from the oral cavity to the terminal ileum is a constant occurrence, and it is most remarkable that these forms of infection do not occur with greater frequency.

THE LYMPHADENOID TISSUE

The important rôle played by the lymphadenoid tissue of the alimentary canal is only correctly appreciated when one realizes the great frequency with which it becomes involved in the various diseases known to clinical medicine. The tangible knowledge indicates an astonishingly large incidence of involvement of the mesenteric glands in typhoid and paratyphoid fever, in the various forms of bacteriemia, in status lymphaticus, in tuberculosis, rarely in lues and actinomycosis, more commonly in the various blood dyscrasias, in a case of agranulocytosis reported by Felsen, and in the various forms of colitis, enteritis, and dysentery. This list does not include the various forms of malignancy and such borderline lesions as Hodgkin's disease. As indicated previously, in some of these, such as typhoid fever, the mechanism of development and of the transit of the infection is well known. The newer anatomical knowledge in colitis and dysentery indicates a fairly close approximation to the latter.

In all forms of diarrheal disease in infants and children—infantile diarrhoea, cholera infantum, acute ileocolitis in infants and children, summer diarrhoea, etc., the process seems centered in, or to show a predilliction for, the vicinity and substance of the intestinal lymphadenoid nodules and is especially marked in Peyer's patches. Apparently all of these forms begin as surface infections and reach down into the substance of the intestinal wall as the pathological process proceeds. The spread into the wall occurs along the lymph channels into collections of lymphadenoid tissue —solitary follicles, Peyer's patches. Wherever, in the various publications (Holt, Felsen, etc.), particular attention is paid to this element and the findings recorded, it is astonishing to see how much and how often other specific mention is made of the localization about, and the involvement of, Peyer's patches. In this regard the differentiation between small and large intestine is merely a quantitative one and depends upon the distribution of solitary and aggregated collections of lymphadenoid tissue—solitary follicles—Peyer's patches. In the small intestinal cases, it is common to find the lesion localized for the most part or limited to the lower ileum where the lymphadenoid tissue abounds to such a large extent in the intestinal wall. The spread into, and the involvement of, the adjacent tissues of the intestinal wall becomes visible only with the prolongation of the illness and its anatomical development.

So-called "catarrhal" infections are commonly associated regionally with the upper reaches of the alimentary canal and have been previously referred to under the general nomenclature of "throat" infections. For the most part these occur anatomically in relation to the lymphadenoid apparatus of the tonsils and adenoids and their secondary involvements in the cervical glands. They are commonly said to be "surface" infections. Whether such "catarrhal" infections

can occur deep down in the ileum and originate in and about the Peyer's patches is something which is apparently beyond the present available powers of demonstration; but certainly it is so that in simple mesenteric adenitis without other demonstrable lesions there is identical symptomatic and anatomical manifestations to those similar lesions that originate in the oropharynx. The interplay of "throat" infection with abdominal symptoms as indicated in this communication is more than a mere coincidence and is remarkable.

INTRA-ABDOMINAL LYMPHANGITIS

Our entire conception and assumption regarding the clinical importance of intra-abdominal lymphangitis and lymphadenitis must be revised. Up to the present these have been accepted too lightly and in an indefinite way and have not been adequately correlated with the observable subjective and objective symptomatology.

Pribram's observations as to lymphangitis in the mesenterium will deserve attention. Pribram (1926) emphasized the occurrence of lymphangitic alterations strongly, and described the appearance of chronic lymphangitis in the mesenterium emanating from insignificant—possibly not even noticeable—inflammatory alterations in the intestinal wall. According to Pribram the altered lymphatic vessels in the mesenterium may be observed as strings, even of the thickness of the radial artery. Pribram considers that the glandular alterations he has observed, now as acute enlargements, now as cicatricial processes with periadenitis, play a less predominant symptomatic rôle than lymphangitis. Pribram's interpretation has followed the commonly accepted assumption that the appendix was at the bottom of the trouble, but he notes that even after appendicectomy the process showed a tendency to successive spreading and occasional recrudescence, leading to shrinking of the mesenterium and diffuse adhesions in different parts of the abdominal cavity, owing to the spreading of the infection in the subserous lymphatic plexus. The lymphatic vessels of the portal fissure become infected in the same way, resulting in the pericholecystitis, periduodenitis, and possibly in a consequent spread of the infection to the pancreas. Pribram attaches great importance to the mesenteric alterations he describes. They are, he thinks, often the cause of discomforts after appendicectomy in cases of chronic appendicitis and are a link with other more or less obscure abdominal affections, e.g., pancreatitis and peptic ulcer. Appendicectomy and cholecystectomy, respectively, at an early stage are recommended also in clinically slight cases as prophylactic measures.

In spite of the fact that some of Pribram's conclusions are, perhaps, rather far fetched, his opinion regarding the clinical rôle and importance of intra-abdominal lymphangitis, and regarding the diagnostic importance of any residual anatomical alterations in connection with any preceding organic abdominal affection, should be well taken. Evidences of the latter abound on all sides; and I am sure that almost every operating surgeon can well remember many instances during a laparotomy in which evidences of preceding lymphangitis of greater or lesser extent were observed in the absence of other demonstrable lesions. As a matter of fact many of the instances in my own experience were explorations in which we were puzzled by the subjective symptomatology and the laparotomy was undertaken in an effort to find adequate cause and cure for the symptoms. Up to the present time these have been accepted, sometimes as being anatomical variations—adhesions—at other times as being evidences of some previous condition which we were too ready to accept as having no relation to the observed symptoms, but as one looks back upon his experience he can easily remember cases in which these areas directly connected with contiguous lesions in the bowel wall. To take an exaggerated example, a carcinoma or a diverticulitis of the sigmoid commonly presents visibly enlarged lymphatic channels and, in later cases, a secondary shriveling of the mesosigmoid, with enlarged palpable lymph nodes nearby. Nevertheless, it seems now that these opinions must be revised even if we are not quite ready to accept the assumption *in toto* that all of these patients suffer from such abdominal discomforts really suffer from some form of lymphangitis or adenitis. And in cases of this kind, the importance of the primary organic infection as a point of origin for any secondary lymphangitis and lymphadenitis must not be lost sight of as contributing in some part at least to the observable symptomatology.

PATHOLOGY

In acute cases intra-abdominal lymphadenopathy occurs: (1) as part of a generalized adenopathy; (2) as an initial involvement of one group of glands with spread to other groups; and (3) as limited to one anatomically differentiated group of glands. Even though chronic adenopathies may begin in any of these ways, the rule is to find only one group of glands involved, although exceptions occasionally occur.

Evidences of any distinct inflammatory process are not always present in the glands which are removed for study. In general, all kinds of simple

hyperplasias and sinus catarrhal exudates are seen and in severe cases purulent fusions and frank abscess formation as well. In severe cases local and general forms of peritonitis occur either by transudation of infectious material or by perforation of glandular abscesses.

In the chronic cases the immediate impression is that lymph gland enlargement is due to some long standing—chronic—form of infection of immediately undeterminable etiological classification. The observable anatomical facts are frequently and commonly not easy to differentiate and classify. Commonly one questions the rôle of tuberculosis; or one suspects an early stage of Hodgkin's disease or other form of lymphatic malignancy; or it may happen that one is not impressed with the presence of enlarged glands and dismisses them lightly as of no importance. And usually, in the absence of any final conclusion, the patient is referred to the follow-up clinic for further observation and study.

In both acute, and, more commonly, in the chronic cases giant cell systems are seen in the histological sections of some of the cases. Such giant cell systems or collections of epitheloid cells approach and are frequently indistinguishable from those of tuberculosis; but the tendency to retrogress without excessive scarring, and the absence of caseation and acid-fast bacilli in them, contradict this. They are usually found associated with severe infection of the alimentary canal accompanied by necrosis. Inasmuch as in the very much milder form of nonspecific adenitis only a hyperplastic condition is present in the lymph nodes, indicating a correspondence of intensity of process between the lymph node picture and the picture in the intestinal tract, it must be assumed that the differences in anatomical picture is caused by the different gradations of toxicity of the etiological cause or of the size and intensity of the dose of the causal agent which is delivered.

One must also assume that the so called "tubercle" arrangement can be found not only in specific forms of infection, like tuberculosis, and lues, but also in forms of nonspecific infection in which up to the present time no definite cause can be assigned. It might very well be that this sort of picture represents the anatomical progression between simple forms of lymphadenopathy on the one hand and those of definitely specific anatomical pictures, which are customarily correlated less often with lues and especially with tuberculosis. Undoubtedly, this also explains the confusion which occurred, not only in the earliest historical period of this subject, but even in later times, in classifying all forms of enlargement of the mesenteric glands as tuberculous.

Mixed infection in tuberculous adenitis plays a very important rôle. It is commonly noted in the neck. Less frequently it is observed in the abdomen. In such mixed infections the anatomical picture sometimes is vague enough to make it difficult to say definitely whether the infection is originally tuberculous even though from clinical experience we may feel fairly sure that it is. Mixed infection of tuberculous glands are commonly severe enough to cause sufficient destruction to wipe out a good deal of the glandular structure, so that the original tuberculous formation cannot be visualized.

RELATIONSHIP OF TUBERCULOUS INFECTION TO ACUTE AND CHRONIC INFLAMMATORY ENLARGEMENT OF THE INTRA-ABDOMINAL LYMPH NODES

In many of these people there is a history of heavy exposure to tuberculosis in childhood, but at the time of examination evidences of tuberculosis are not obtainable either by physical examination or by laboratory tests. In girls there is sometimes more than the usual rise in temperature at the time of menstruation.

Physical examination generally shows a thin nervous young woman with a temperature around 100 degrees F. or less, and a tender abdomen. Sometimes an appendicectomy has already been done; at other times that is presented as the question at issue. Roentgenographic evidence of disease of the stomach, gall bladder, and colon will not show anything abnormal, but occasionally calcified intra-abdominal lymph nodes are visualized.

Many an anatomical diagnosis of tuberculous mesenteric adenitis has been, and continues to be, made upon the roentgenographic demonstration of calcifications in the general region of the lower right abdominal quadrant. Pribram was of the opinion that glandular calcifications might set in as a final stage of any pathological process without having been preceded by a tuberculous infection. Noeske had also subscribed to the same opinion. In the former case, none of the observers had any method of establishing reliable proof except for the demonstration of the presence of tubercle bacilli which was frequently not available. In the latter group the contrariwise opinion was held because tubercle bacilli were not demonstrated and because of other clinical and collateral knowledge.

That inflamed and enlarged mesenteric and retroperitoneal glands, non-tuberculous in origin, do occur is well known. In his recent paper on

abdominal pain in children, Hutchison emphasized the importance of enlarged glands in the causation of abdominal pain in children.

Personally, I am convinced from all of my experience, that although tuberculous infection is well known and has been adequately proved to exist in the mesenteric and other abdominal lymph nodes, there are also other cases of chronic inflammatory enlargement of these nodes with and without necrosis and with or without calcification, which are not caused by infection with the tubercle bacillus.

COMPLICATIONS

The following complications have been reported in both acute and chronic intra-abdominal lymphadenitis: (1) massive invasion of the entire lymphatic chain, (2) suppurative periadenitis with infiltration of the mesentery or with the formation of a tumor-like mass, (3) intra-abdominal abscess resulting from the rupture of a suppurative gland with or without local and general forms of peritonitis, (4) erosive bleeding from a large intra-abdominal blood vessel, (5) thrombosis of some vessel in the mesenteric plexus, (6) compression of a hollow viscus by enlarged inflamed glands, (7) intestinal obstruction, (8) obstruction of the biliary ducts, (9) compression of the ureter with secondary hydronephrosis.

SUMMARY AND CONCLUSIONS

A number of concepts have resulted from this factual review:

1. A very important common denominator of all of this aggregation of facts is the age factor. It is apparent that all of the conditions herein reviewed with which general and mesenteric lymphadenopathy is associated occur in the period of life beginning with childhood and extending with less frequency up to the adolescent period. It appears from this that during this period of life the lymphatic apparatus of the human being is under continual and variegated stress and is most apt to undergo pathological changes.

2. The streptococci are most frequently associated with the various forms of so called nonspecific lymphadenopathy and with the various clinically differentiated illnesses herein referred to. To be sure other organisms—staphylococci, diplococci, melitensis, etc.—are named even in conditions not specifically defined as a clinical disease such as typhoid fever, etc., but the predominating organism is the streptococcus. I am more and more impressed by the frequency with which causal agents of disease attack and enter the body through the upper end of the alimentary canal—oronasopharynx. There is a good deal of evidence that the association of infection at the beginning of the alimentary canal—oropharyngeal cavity—with the abdominal manifestations centering in the general region of the terminal ileum is no mere coincidence. Corroboration of this is obtained in both experimental work (Poynton and Payne, and Adrian), and in clinical practice. Similarly, in the literature, reference has been made to the connection between appendicitis and an original oropharyngeal infection. I am also struck with the importance of an allergic mechanism in many of the previously mentioned conditions in which abdominal lymphadenopathy occurs. The rapid and abundant distribution of an exanthematic rash is probably based on an allergic distribution. In the visceral crises the edematous areas in the intestinal tract show remarkable similarities to external forms of angioneurotic edema and are undoubtedly indicative of a similar mechanism. Various forms of purpura commonly accompany the visceral crises. In the hyperacute fatal form of purpura there is indication of an overpowering biological mechanism, and no other branch of medicine comes so quickly to one's mind as that pertaining to allergic phenomena. Most probably the allergic antigen in any case is a bacterial product. Some of the phenomena remind one of histamine poisoning: and histamine-like bodies are found commonly in the intestinal tract.

3. The great facility with which generalized or mesenteric lymphadenopathies are associated with many apparently widely differing diseases indicates the great tendency for lymphatic absorption of these diseases during this period of life. It is practically impossible to obtain an accurate visualization of the general and ordinary condition of the enormous surface extent of the mucous membrane of the intestinal tract especially of the jejuno-ileum. It seems highly probable, nevertheless, that more frequently than one ordinarily imagines, there is some inflammation of this membrane, i.e., enteritis. There is every reason to believe that such inflammation can be responsible for many hitherto not sufficiently explained abdominal symptomatologies: acute and chronic upsets in digestion, cyclic vomiting, etc., which are now thought to be "functional" in origin; for many cases of diarrhea for which, at present, no adequate cause can be found; and for some other transient disturbances in the functions of the stomach and bowel, which so commonly accompany "colds" or "throat infections" or other generalized infections. Accurate correlation and integration of these symptomatologies with the little and infrequently available knowledge obtained during postmortem examination is difficult. Com-

mon bacteriological causes for such transient and often unrecognized forms of enteritis may be the organisms or their toxins of the dysentery, enteritides, and colon groups of bacteria as well as staphylococci and streptococci. The studies of Childrey, Alvarez and Mann indicate that the digestive upsets that follow the eating of too much food or of undigestible food may well be due to injury wrought in this way to the absorptive power of the mucous membrane of the small bowel.

4. Intra-abdominal lymphadenopathy occurs under several basic conditions: (a) as an accompaniment or integral part of some definite disease, such as typhoid fever, dysentery, etc.; (b) as a secondary manifestation to some intestinal lesion of more or less obscure origin such as nonspecific granuloma of the intestine; (c) as an incompletely understood accompaniment of indefinite groups of diseases usually associated with streptococci of one or another strain—the "rheumatic" group, for instance; (d) as a lymphadenopathy without any demonstrable or discoverable preceding causal lesion either nearby or at a distance, that is, nonspecific mesenteric adenitis.

5. The dominating position of the isolated and aggregated collections of lymphadenoid tissue at those points of the alimentary canal—oronasopharynxileum—where physiological activity and stress is normally at a maximum, where bacterial attack is most apt to occur, where the products of bacterial attack and invasion are therefore, most commonly developed and absorbed, neutralized without perceptible evidence, or counteracted, blocked, and destroyed in the appropriate associated lymph nodes in the manifestations of disease. In intra-abdominal lymphadenopathy this corresponds to nonspecific mesenteric adenitis.

6. The great similarity in anatomy, physiology, etiology, mechanism and pathology between such forms of disease originating in the oronasopharynx and that originating in the lower ileum in either case lead to nonspecific forms of lymphadenopathy. This fact must be emphasized in order to wipe away any question of obscurity with which nonspecific mesenteric adenitis has been surrounded.

7. The similarity of the anatomical changes in the mesenteric nodes of the nonspecific type and those in the lymphadenopathies which occur in the other collateral or specific groups of diseases are reviewed herein.

8. In the great majority of the cases of nonspecific mesenteric adenitis it is not possible to prove any definite tuberculous etiology; nor do the clinical facts give any reason for suspecting or believing that the great majority of these conditions are tuberculous.

One must get away from the idea that mesenteric adenitis is some isolated, bizarre, peculiar, or obscure disease. Rather one must understand that it has its counterparts in other lymphatic regional areas, that it is a sequel of other disease and infections, that it is a constant secondary phenomenon in many acute and chronic, mild and severe diseases of the intestinal tract, and that no one etiological factor or cause is responsible for the condition. This is not only my own opinion but has been pointed out also by Strömbeck.

Inasmuch as in many cases abdominal lymphadenopathy is part and parcel of some larger definite clinical entity, treatment must follow along the lines known by experience to be correct and adequate for the original disease. In nonspecific mesenteric adenitis and in the absence of any suppuration or other complication, none but conservative treatment would be indicated if one could so perfectly diagnose the condition that the fear of an undiscovered acute appendicitis or other surgical emergency could be definitely eliminated. Unfortunately, this is not possible at the present writing in clinical practice, and abdominal explorations are more or less frequently necessary in order to establish the true nature of the intra-abdominal condition.

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THE RÔLE OF CONSERVATIVE PROCEDURES IN TREATMENT OF SURGICAL EMERGENCIES

IT is of the utmost importance for the surgeon called on to perform emergency operations to realize that with each patient he faces two distinct major problems; first, the saving of a life and, second, the correction of a pathological condition. Naturally, their respective importance is in the order named, but, because of zeal to effect a cure, it is sometimes easy to overlook the immediate problem at hand, namely, the preservation of life. For the latter often a temporary or palliative type of emergency operation will be sufficient to correct the physiological disturbance. After the patient's condition improves, radical corrective procedures can be undertaken with reasonable safety. The problem in emergency operations is entirely different from that presented by the patient with a more or less chronic ailment amenable to surgical treatment, who, being otherwise in good condition and electrolyte balance, can be subjected safely to the needed corrective operation usually at one stage.

Before any emergency operation, likewise, two other important problems should be solved if the surgeon is to give the patient the entire benefit of present knowledge and meet successfully the major problem, that of preservation of life. These are, first, an accurate pre-operative diagnosis and, second, adequate pre-operative preparation. The diagnosis, "surgical abdomen" was often justifiable forty years ago, but is permissible today only occasionally with the laboratory procedures, and stored blood and plasma which are now available to the surgeon. A few years ago the surgeon was forced to operate on patients in shock because intravenous infusions, blood and plasma were not available, but with these agents at hand the patient's condition can be improved before operation and during these extra minutes or hours, as the case may be, an accurate diagnosis can be made. Certainly a patient who has pneumonia or coronary thrombosis is never improved by exploratory laparotomy and without a careful, accurate diagnosis each can be mistaken readily at times for a "surgical abdomen." Likewise, intravenous fluids in the quantity used in combating shock would only add to the gravity of the situation if administered to a patient following an acute coronary accident.

The value of intravenous fluids in cases of intestinal obstruction has been appreciated for almost two decades. It is not generally known, however, that children and infants are especially vulnerable when subjected to surgical procedures when their fluid balance is poor. Also, any patient who gives a history of vomiting or ileus should not receive an

anesthetic until a stomach tube has been passed and the stomach emptied of its contents.

If all problems in emergency treatment were as direct as that of early uncomplicated acute appendicitis in which both the problems of urgency and cure are settled, there would be no excuse for this dissertation. Fortunately, the same is true in the majority of cases of acute cholecystitis, perforated peptic ulcer, strangulated hernia, ectopic pregnancy, and twisted or bleeding ovarian cyst. Because of the relative good condition of the patient, who has one of these lesions, life may be preserved and a cure effected at one operation. Unfortunately, some patients present a graver problem because of their poor condition, or the nature of their affliction, and a conservative procedure only must be performed that may or may not also result in cure of the pathological condition. This probably was first appreciated in the management of acute obstruction of the large bowel and it is now the accepted procedure, if the obstruction does not subside in a few hours after institution of conservative measures, to perform cecostomy or colostomy and to defer removal of the obstructing lesion until the obstruction is entirely relieved. This course allows time for evacuation and cleansing of the bowel, which is so important in the preparation for operations on the colon. Likewise, when an infant, an aged patient, or a patient in poor condition has a strangulated intussusception of the intestine, volvulus, or hernia, an exteriorization operation with proximal enterostomy as an emergency procedure gives a much greater hope of recovery than resection and a primary anastomosis. The intestinal continuity can be re-established with considerably less risk a few days later when the emergency is over. The fact that the intestinal obstruction is the item of first importance should be remembered in dealing with strangulated hernia and not the herniorrhaphy.

Any more radical procedure than simple closure of an acutely perforated peptic ulcer doubles the mortality rate. Since 80 per cent of patients remain well after this conservative procedure and usually medical regimen has not been tried, there seems to be little excuse for subjecting a patient in shock to gastroenterostomy or gastric resection. The effectiveness of medical regimen, which may be used to prevent further operation, is portrayed by patients with chronic duodenal ulcer. In these cases medical regimen almost invariably is advised and operation is required for relief in only about 15 per cent. In operating on the acutely inflamed gall bladder, the experienced surgeon will be able to accomplish cholecystectomy without difficulty in most instances. Occasionally, however, its removal will be hazardous because of the extent of the inflammation present or the poor condition of the patient. In such cases cholecystostomy can be performed unhesitatingly with the assurance that 85 per cent of such patients will not require cholecystectomy later. The management of perforation of the appendix with peritonitis is a controversial subject, but most surgeons who pursue an operative or radical policy become very conservative as soon as the peritoneal cavity is entered. Frequently, only drainage is instituted unless the appendix is free and readily accessible and the patient's condition warrants its removal. Great care is taken to prevent the breaking up of protecting or walling off adhesions. If a localized abscess shows no signs of resorption, it is drained, and if appendectomy is not accomplished at the primary operation its removal is recommended in the interval.

The gross mortality rate with emergent abdominal surgical procedures in experienced

hands is in the neighborhood of 10 per cent. The employment of preliminary conservative procedures in certain complicated problems could lower this figure appreciably.

JOHN M. WAUGH.

ADVANCES OF ABDOMINAL SURGERY IN INFANCY

THERE is probably no field of surgery that has been overlooked so much as that pertaining to infants and children. In fact, it is only within the past 5 to 10 years that any appreciable proportion of the medical profession has realized that the infant and child are subject to almost all the pathological conditions found in adult life plus many conditions never seen in the older age group. This change in point of view is strikingly evidenced by the great increase in the number of articles on children's surgery appearing in the leading medical journals and by the tremendous increase in the demand by young men for training in this field of surgery. Of course, with this increased interest in a particular phase of surgery there has been a marked improvement in the results obtained.

This improvement has been especially striking in the abdominal surgery of infants. It is interesting to recall that although congenital pyloric stenosis was well described by Beardsley as early as 1787, little or no attention was paid to the condition for well over a hundred years. Untold hundreds of infants must have died of this condition in the years intervening between then and the present day. In fact, even in the very recent past the mortality remained over 50 per cent, but today in well organized children's surgical clinics the mortality has dropped to a fraction of 1 per cent. This desirable change has come about by earlier recognition of the condition with an earlier diagnosis, by better preoperative preparation of the patient, by improved operative technique, and by more intelligent postoperative care.

In 1916 Holmes made a careful examination of 120 pathological specimens of atresia of the bile ducts which showed that an appreciable number of these patients had ducts available for anastomosis to the bowel for any surgeon who wished to make the attempt. Yet it was not until 1927 that the first successful anastomosis of a congenital atresia of the bile ducts was performed. Since this first successful operation was performed at The Children's Hospital of Boston, 6 other cases of atresia of the extrahepatic bile ducts have been successfully operated on, and more than this number of cases of stenosis of the ducts have been relieved by surgical means. The relief in both groups has been permanent. It appears that over 20 per cent of the cases of congenital obstruction of the bile ducts are amenable to surgical relief and that in this group the operative mortality is not unduly high. It is surprising that there are not more successful results reported in the current literature.

Until very recent years the cure of a patient suffering from congenital atresia of the intestine was regarded as a surgical curiosity, but reports of successful results are becoming much more common. Were it more generally appreciated that any infant who starts vomiting on the first day of life and continues to do so may be suffering from this condition, and were it also appreciated that the diagnosis can be simply and accurately made in the vast majority of instances, the successes would increase even more rapidly. A single x-ray plate without the use of contrast media will not only suggest the diagnosis of intestinal obstruction but will often indicate the approximate site of the obstruction. The optimum time for performing these difficult anastomoses is within the first 48 hours of life. At this age infants

stand major surgical procedures extremely well. The mechanical difficulty of excessive distention has probably not taken place and gangrene of the bowel with perforation and peritonitis has not developed. It is still all too common for such infants not to be referred to the surgical clinic until they are *in extremis*. Of course, it must be recognized that special surgical technique is required for such cases, but this has already been developed in several clinics and should be developed in many more in the near future.

The intestinal obstruction due to faults of rotation, though often not complete and therefore not quite so urgent as the atresias, still present serious problems of early life. With our present knowledge of these conditions and the methods of surgical approach they can be effectively and permanently relieved in most instances.

In 1931 Hedblom showed that 75 per cent of infants having diaphragmatic hernia died before the end of the first month of life, and the mortality would be higher if the hernia through the esophageal opening had been excluded. If in newborn infants presenting symptoms of cyanosis, circulatory difficulty, or vomiting, the possibility of diaphragmatic hernia were more commonly considered, many fatalities from this condition could be avoided. Here again, as with the atresias of the bowel, an x-ray examination without the use of contrast media will usually give an accurate diagnosis. When a diagnosis has been made of diaphragmatic hernia of major degree in the newborn infant, operation should be resorted to without delay. The policy of delay has yielded a mortality of over 75 per cent in the first month of life, whereas recognizing that the optimum time for surgical intervention is in the first 48 hours of life has reduced it tremendously. In the first two days of life the distention has not become marked and there is a better chance of being able to replace the abdominal viscera within the peritoneal cavity without undue pressure. When the tension of closing the abdominal wall is too great, a two stage closure has been proved to be a life-saving procedure. If this present plan of procedure is followed, it should be possible to reduce the present high mortality by 50 per cent or more.

These are but a few examples of the marked recent changes and advances in the field of abdominal surgery of infants. The knowledge of the pathological conditions which exist at this age, the development of suitable surgical technique, and the correct postoperative care of those small patients have also produced similar improvements in surgical conditions involving other parts of the body in newly born infants.

WILLIAM E. LADD.

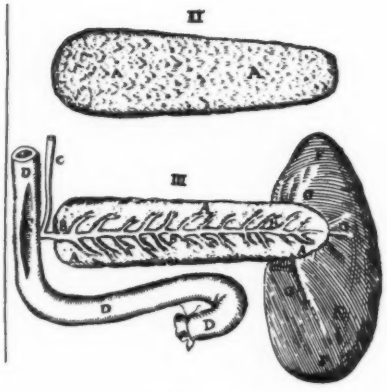

FIG. II.

AA *The Body of the Sweet-bread deciphered in its Natural form.*

FIG. III.

The back-part of the Sweet-bread, together with the Spleen turned downwards.

AA *The substance of the Sweet-bread, its Membrane being taken off.*

BBB *The channel of the Sweet-bread newly found out.*

C *The biliar pore joyned to the channel.*

DDD *A portion of the Guts* Duodenum *and* Jejunum, *cut off.*

E *The common Orifice, by which the biliar pore and channel of the Sweet-bread, open themselves into the* Duodenum.

FFF *The internal face of the Spleen.*

GGG *The veins and arteries distributed into the Spleen.*

Fig. 1.

The Sweet-bread [*Pancreas*] is a Glandulous part of the *Abdomen*, very profitable for attenuating and purging the *Chyle*, and preparing it for the Liver and Spleen before it be turned into blood, for as Nature deduceth the blood it self, which is either for nourishment of the fruit in the womb, or to make the seed for the Generation of it, by divers degrees or steps, even so the Juyce which it turns into blood, it alters it in the mouth, concocts it in the Stomach, easeth it of excrements by the Bowels, and by the sweetness of the Sweet-bread, frees from sharp and salt humors, and therefore the Sweet-bread is alwaies full of *Chyle*, as you may find if you dissect a creature alive, and cut it with a knife.

Also there is a most observable and singular channel in the Sweet-bread, lately found out by our *Wirsungus*, which to a curious eye carries the structure and shew of a vein: It ariseth from the Gut called *Duodenum*, sometimes in the extremity of the biliar pore, having a common Orifice with an outward shut, sometimes neer the biliar pore, from a distinct place; it is stretched transversly in the Sweet-bread with short, yet very many branches; it is wide at the beginning, and consumes by degrees before it come at the extremity of the Sweet-bread; sometimes it is double in man, but unequal in length, and ariseth neer the biliar pore at about a fingers bread distance.

The use of this channel is no waies hard to be found out, for seeing it brings a certain sharp juyce not unlike to the Gall, it separates the juyce of its own Nature from the *Chyle*, and carries it away to the Gut *Duodenum*, and therefore this being stopped, the Sweet-bread swels by reason of the excrements retained; and so, many vessels being by this means compressed, the Liver and Spleen receive no small damage.

Fig 2.

Reproduced from Vesling's *Anatomy*.

On the Use of the Lay Term "Sweet Bread" for the Pancreas.—Arno B. Luckhardt

TEXTS AND DOCUMENTS

ON THE USE OF THE LAY TERM "SWEET BREAD" FOR THE PANCREAS

ARNO B. LUCKHARDT, M.D., Chicago, Illinois

MANY years ago the writer was mildly curious to know why the pancreas (among others) was called the sweet bread by meat vendors and the laity. Looking up the term in a few dictionaries did not help in clearing up this curiosity, since they wrote: "Sweet bread. The thymus gland (*neck s.*, or *throat s.*) or the pancreas (*abdominal s.* or *stomach s.*) of an animal used for food."[1] Or "Sweet bread. The pancreas and thymus."[2] And "Sweet bread. The pancreas of an animal, used for food; also, the thymus gland so used." But others distinguish the two, the former being the stomach sweet bread, the latter the neck sweet bread or throat sweet bread.[3] These statements obviously, only denote the gland but do not indicate why the pancreas was called "sweet" instead of "sour" or "bitter."

The answer came several years later when I came in possession of an English edition of Vesling's *Anatomy*.[4] It was in Professor Vesling's anatomical laboratory that Wirsung (Versungus) first discovered in 1642 the pancreatic duct—in fact, the first duct coming from any gland of external secretion. Figure 1 reproduced from Vesling's *Anatomy* illustrates pictorially with legend the original illustration by Wirsung.

The second reproductions (Fig. 2) comprise selected passages from the old "englished" text.

If the modern reader will recall that in these early days the word "chyle" really meant "chyme," it will be clear from the text that it was thought that the "chyme" passed up the pancreatic duct from the intestine and that the pancreas removes from the "chyme" "sharp and salt humours."

However, the third paragraph selected and here reproduced indicates that there was also a downward movement of fluid into the intestine consisting in a "certain sharp juyce not unlike the gall" to the duodenum and indicates that if this passage of a sharp juice downward is stopped the "sweet bread swels by reason of the excrements retained; and as a result the liver and spleen receive 'no small damage.'" An acute infectious pancreatitis is what the writer probably had in mind.

As in many other physiological matters it did not bother our forefathers to explain the mechanism by means of which materials would pass up and down the pancreatic duct simultaneously.

[1] Stedman's *Medical Dictionary*, 1918, p. 962, c.

[2] Robley Dunglison's *Dictionary of Medical Science* as revised by Richard J. Dunglison, M.D., p. 1007, a. Philadelphia: Henry C. Lea, 1874.

[3] The *Century Dictionary, An Encyclopedic Lexicon* of the English Language, etc., p. 6108. New York: The Century Co., ca. 1914.

[4] *The Anatomy of the Body of Man:* Wherein is exactly described every part thereof in the same manner as it is commonly shewed in public anatomies, etc. Also explanations of every particular expressed in copper plates. Published in Latin, by Joh. Veslingus Reader of the Publick Anatomy in the most Famous University of Padua, and Englished by Nich. Culpepper Gent. Student in Physick and Astrology. London, at the Bible on Ludgate Hill, 1677, pp. 15 & 16 and illustrations between pp. 18 and 19.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE book *Bacillary and Rickettsial Infections* by William H. Holmes[1] should have a wide appeal to those physicians and medical students who have a scholarly interest in disease. This volume takes up the large group of infectious diseases caused by bacilli and by rickettsia; namely, the enteric infections, diphtheria, tetanus, gas gangrene, botulism, undulant fever, tularemia, plague, tuberculosis, typhus, spotted fever, and a number of less important infections. The picture of each disease is presented against a rich historical background which gives the reader a sense of perspective. The development of our knowledge concerning the disease and its effect on human history are sketched in vivid terms. Consequently, when the symptomatology and laboratory findings are discussed, one gets a splendid conception of the disease as a historical, clinical, and scientific entity. Dr. Holmes' style is eminently readable, his arrangement of material with comments in small type along the margin a useful one, and the profession owes him a debt of gratitude for introducing both scholarship and good literary style into sound medical writing.

The book was written as a textbook. The essential facts about the etiology, pathology, and symptomatology of these infections are clearly presented, but these sections are not comprehensive enough to make the volume a useful reference work. Bacteriologists may well be disappointed by the small space devoted to bacteriology and immunology. Clinicians may feel that insufficient emphasis is placed upon differential diagnosis and treatment. However, the author did not set out to write a reference book, but rather an introduction to the study of medicine, or an "orientation in medicine" as the publisher describes it. In this he has succeeded admirably. For the second year student in bacteriology, Dr. Holmes' book will give meaning to his long hours of laboratory work. If students in the third and fourth years take up the study of the infectious diseases with this book, they will gain an insight which can never come from mere study of the ordinary textbook. Later in their careers they may wish to consult the larger systems for information on specific points, but this volume will give them an admirable understanding of the disease as a whole. Older physicians will find fascinating reading in these chapters, which will not only refresh and supplement their medical knowledge, but also rekindle some of the enthusiasm of their student days.

Perhaps Dr. Holmes should be commended most highly for the broad outlook on medical problems which he has skilfully woven into the text of his work. In the chapters on tuberculosis particularly, he has shown how closely the disease is intertwined with the social and economic problems of our society. This book sets the infectious diseases in their proper perspective in the field of medicine and human relations, and every medical student who aspires to be more than a mere craftsman should study this volume during the course of his training.

CHARLES A. JANEWAY.

Since this review was received, Dr. Holmes passed away on November 2, 1940.

THE small textbook, *Practical Dermatology and Syphilis* by Robinson,[2] is a compend intended primarily for the medical student. It is a synopsis of most of the common skin diseases found in the average standard textbook of dermatology. Its purpose, perhaps, is much the same as that of the *Synopsis of Medicine* by Henry L. Tidy, namely, to assist those who wish to review rapidly their knowledge of dermatology.

The general arrangement of the book follows that of the larger, more comprehensive textbooks on the subject, and, while the subject matter is very briefly handled, in most cases the descriptions are adequate.

There are 439 photographs, but they are reduced so much in size that they fail to serve their purpose, that of giving the student an adequate picture of the disease. Then, too, they show many defects in lighting, depth, and sharpness of focus.

The book can only by recommended to beginners in dermatology as a primer, with emphasis on the warning of the author that for more comprehensive study and reference a more extensive textbook should be consulted.

EDWARD A. OLIVER.

THE authoritative monograph, *Lipidoses: Diseases of the Cellular Lipid Metabolism*[3] originally written as a section of *Oxford Loose-Leaf Medicine*, includes studies on lipid metabolism begun 20 years ago by the author and his associates. The subject is presented in five parts: physiology and chemistry, hyperlipemia, xanthomatosis, Gaucher's disease, and Niemann-Pick's disease. Clinical examples of the various conditions described are numerous and the

[1] BACILLARY AND RICKETTSIAL INFECTIONS ACUTE AND CHRONIC; A TEXTBOOK; BLACK DEATH TO WHITE PLAGUE. By William H. Holmes. New York: The Macmillan Co., 1940.

[2] PRACTICAL DERMATOLOGY AND SYPHILIS. By Harry M. Robinson, M.D. Philadelphia: P. Blakiston's Son & Co., Inc., 1939.

[3] LIPIDOSES: DISEASES OF THE CELLULAR LIPID METABOLISM. By Siegfried J. Thannhauser, M.D., Ph.D. Edited by Henry A. Christian, Am., M.D., LL.D., Sc.D. (Hon.), F.A.C.P., Hon. F.R.C.P. (Can.). Reprinted from *Oxford Loose-Leaf Medicine*. London, New York Toronto: Oxford University Press, 1940.

book contains many illustrations and tables. An extensive bibliography follows each section.

PAUL STARR.

THE anatomy, histology, and embryology of the vulva are first briefly considered in *Diseases Affecting the Vulva* by Hunt[1]. The morbid conditions affecting the vulva are then described. As the author states, these conditions, with few exceptions are cutaneous lesions. Each condition is considered from the standpoint of etiology, histopathology, clinical manifestations, and treatment. The volume contains 18 beautiful reproductions of colored photographs from the author's own collection. It is a fine example of what an important place color photography occupies in present day medical teaching. This work is unique in that it is a treatise on dermatological lesions of one *area* of the body; however, the dermatologist and the gynecologist as well as the general practitioner will find it helpful in identifying skin affections of the vulva. CHESTER C. DOHERTY.

A SECOND edition of the *Directory of Medical Specialists*, complete to January 1, 1942, will be distributed in February by the Advisory Board for Medical Specialties. This directory will list some 18,000 diplomates of the fifteen American Boards examining candidates for certification in the specialties, an increase of 4,000 over the first edition.

Various sections give full information about addresses of the diplomates, their formal training, military appointments, and their specialty designations, with examination requirements of each American Board. All men certified by the American Boards are included, the only charge being certification for such listings.

This directory is not a commercial undertaking as it contains no advertising, is underwritten by the Advisory Board, and actually received subsidizing support so that it can be distributed as economically as possible. The diplomates are urged to fill out the questionnaires, which are now out with order forms, and return them as soon as possible. A reduced rate is offered for prepublication orders, as the size of the printing is based on the advance subscriptions.

The publication is issued through the Columbia University Press of New York. The Secretary of each American Board serves on the Advisory Editorial Board, and Paul Titus, M.D., 1015 Highland Building, Pittsburgh, Pennsylvania, of the American Board of Obstetrics and Gynecology, is the Directing Editor.

IN a 450 page volume entitled *Menstrual Disorders and Sterility*,[2] Mazer and Israel review the physiology of the pituitary gland, ovaries, and uterus. Puberty and the normal menstrual cycle are then considered briefly and an evaluation of the normal menstrual hormone balance attempted. The changes occurring in both normal and abnormal menstruation are considered and the symptoms attending abnormal menstruation are taken up in their usual order of appearance, this phase naturally beginning with dysmenorrhea. Amenorrhea, the many etiological factors concerned with its production, and its treatment are next presented. Uterine bleeding due to all causes follows. All causes are considered in order; consequently, some of them are not in any sense menstrual disorders. Bleeding from cancer of the cervix or corpus or from a submucus fibroid or cervical polyp can hardly be classified as menstrual disorders. Bleeding due to a disturbance of the normal physiology concerned in menstruation, the possible factors involved, and the authors' method of treatment, once a diagnosis is established, are then set forth.

A chapter on sterility deals with this subject in a more or less orthodox fashion. Much emphasis is placed on the male factor in sterility studies and the authors give an incidence of 41.5 per cent of male sterility or infertility in a series of 438 cases studied by them. The results of treatment in 202 cases of this total series are presented in table form.

In the preparation of this volume, the authors have drawn freely from the work of other investigators. Due credit is given such investigators and at the end of each chapter there is a complete bibliography of all references. CHESTER C. DOHERTY.

WITHIN the 454 pages of the encyclopedic compend, *Clinical Pellagra* by Seale Harris[3], the story of pellagra is detailed in masterly style from the first reference to the disease that appeared in medical literature by Casal in 1762 to the most recent work of Sutton and Ashworth on the interrelations between vitamin and hormone deficiencies.

The author is eminently qualified to present every phase of this disease, as he has been interested in pellagrous patients since 1908. He has collected the bibliography of at least 5,000 references and over a score of his own writings on pellagra have been published in various scientific journals. Dr. Seale Harris was assisted in this work by his son, Dr. Seale Harris, Jr., and nine collaborators. While the reports of other pellagrologists have added materially to his work in at least two chapters (15 and 16), some repetition has resulted.

Although the treatment of pellagra has been revolutionized since the epoch-making discovery of Elrehjem and his associates in 1937, many controversies still exist regarding its etiology. The chapter on the genesis of pellagra is of particular interest and points out the numerous factors, both extrinsic and intrinsic, which are contributory to its cause. In this respect the similarity of this disease to pernicious anemia and sprue becomes apparent. All the etiologic factors are not yet known. The

[1] DISEASES AFFECTING THE VULVA. By Elizabeth Hunt, B.A., M.D., Ch.B. (Liverp.) St. Louis: The C. V. Mosby Co., 1940.

[2] DIAGNOSIS AND TREATMENT OF MENSTRUAL DISORDERS AND STERILITY. By Charles Mazer, M.D., F.A.C.S., and S. Leon Israel, M.D., F.A.C.S. New York and London: Paul B. Hoeber, Inc., 1940.

[3] CLINICAL PELLAGRA. By Seale Harris, M.D. Assisted by Seale Harris, Jr., M.D. Foreword by E. V. McCollum, Ph.D., Sc.D., LL.D., St. Louis: The C. V. Mosby Co., 1941.

rôle of alcohol is emphasized in explaining the recent increase in the number of cases of pellagra in cities.

In the foreword Dr. E. V. McCollum makes the following statement: "Nowhere else is so complete a history of investigations relating to pellagra, and the assembled quotations and comments make a fascinating story. Clinicians will be entertained and instructed by reading the views of their studious colleague, which point out how, as the result of primary deficiencies, bodily conditions may, through debility and derangement of function of the gastro-intestinal tract and the liver, become unable to utilize indispensable nutrients in an adequate dietary. The book is a distinct contribution in that it extends the deficiency disease viewpoints beyond simple chemical reasoning into the field of perverted physiologic function." HOWARD B. CARROLL.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

SURGERY OF MODERN WARFARE. Edited by Hamilton Bailey, F.R.C.S. Vol. 1. Baltimore: The Williams & Wilkins Co., 1941.

PROCTOLOGY FOR THE GENERAL PRACTITIONER. By Frederick C. Smith, M.D., M.Sc. (Med.), F.A.P.S. 2d rev. edition. Philadelphia: F. A. Davis Co., 1941.

DIAGNÓSTICO DE LAS AFECCIONES QUIRÚRGICAS DEL TÓRAX; PROCEDIMIENTOS Y TÉCNICA SEMIOLÓGICA. By Mario M. Brea and Jorge A. Taiana. Buenos Aires: El Ateneo, 1941.

FRACTURES. By George Perkins, M.C., M.Ch.(Oxon.), F.R.C.S. London and New York: Oxford University Press, 1940.

THE HEART IN PREGNANCY AND THE CHILDBEARING AGE. By Burton E. Hamilton, M.D., and K. Jefferson Thomson, M.D. With a section entitled "Delivery and Obstetrical After-Care of Cardiacs." By Frederick C. Irving, M.D., F.A.C.S. Boston: Little, Brown & Co., 1941.

A PRACTICAL MANUAL OF DISEASES OF THE CHEST. By Maurice Davidson, M.A., M.D. (Oxon.), F.R.C.P. (Lond.). Second edition. London and New York: Oxford University Press, 1941.

THE PHARMACOLOGY OF ANESTHETIC DRUGS; A SYLLABUS FOR STUDENTS AND CLINICIANS. By John Adriani, M.D. Second Edition. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1941.

ESSENTIALS OF DERMATOLOGY. By Norman Tobias, M.D. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1941.

WAR WOUNDS AND INJURIES. Edited by E. Fletcher, M.A., M.B., M.R.C.P., and R. W. Raven, F.R.C.S. Baltimore: The Williams & Wilkins Co., 1940.

TEXTBOOK OF PEDIATRICS. By J. P. Crozer Griffith, M.D., Ph.D., and A. Graeme Mitchell, M.D. Third edition. Philadelphia and London: W. B. Saunders Co., 1941.

FIELD SURGERY IN TOTAL WAR. By Douglas W. Jolly, M.B., Ch.B.N.Z. New York: Paul B. Hoeber, Inc., 1941.

CORRESPONDENCE

FAT EMBOLISM, A CLINICAL AND EXPERIMENTAL STUDY

To The Editor: In my article entitled, "Fat Embolism: A Clinical and Experimental Study," published in the April 1941 issue of this journal, I stated on page 741:

"Decholin sodium (sodium dehydrocholate) has been recommended by Paul deHaen Chemical Company as a therapeutic agent in the treatment of fat embolism."

This statement should have read that Mr. Paul deHaen, president of Riedel-deHaen, Inc., manufacturers of decholin sodium, called my attention to the report by Dr. E. Rappert on November 17, 1938, and suggested that Dr. Rappert's work on fat embolism merited confirmation by further investigation.

I regret that my statement indicated that Mr. deHaen recommended decholin sodium as a therapeutic agent in the treatment of fat embolism. This was an error because, in Mr. deHaen's opinion, the available data are insufficient to justify its use in the treatment of this condition at the present time. I did not wish to misquote a corporation of such splendid reputation. CARLO S. SCUDERI.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

EVARTS A. GRAHAM, St. Louis, *President*
W. EDWARD GALLIE, Toronto, *President-Elect*

Committee on Arrangements
LELAND S. MCKITTRICK, *Chairman;* RICHARD H. SWEET, *Secretary*

PRELIMINARY PROGRAM FOR 1941 CLINICAL CONGRESS

THE thirty-first annual Clinical Congress of the American College of Surgeons will be held in Boston November 3 to 7, when the fellows of this great medical center will sponsor a program of operative clinics and demonstrations covering all phases of surgical activity. The Congress has been held in Boston on several previous occasions, the first in 1915 and last in 1934. These meetings have made notable contributions to surgical and medical knowledge. Those who will attend in 1941 may anticipate a program of broad scope and interest, for the surgeons and clinicians of Boston have complete facilities at their command in the three medical schools and the thirty or more approved hospitals which will participate.

CLINICAL PROGRAM

Under the leadership of a strong and representative Committee on Arrangements, plans are already under way for a complete and varied program for the five-day meeting. An extensive schedule of clinics and demonstrations is being arranged in the hospitals and medical schools which will, as usual, be the major feature of the Clinical Congress. Visiting surgeons will have every opportunity to obtain first hand information on a wide variety of surgical and related subjects as presented in the environment of excellent hospital facilities. In the operative clinics, surgical technique, use of operating room equipment, and organization of personnel will be demonstrated. Symposia and non-operative clinics will deal with the broader and equally important aspects of diagnosis, related non-surgical treatment, pre-operative preparation, and postoperative care, presented by means of discussion and through the demonstration of a wide variety of clinical material. Hospital diagnostic departments will offer important contributions in their respective fields. Specialists in varied fields, as well as surgeons, will participate in the discussions, so that many subjects will receive consideration from different viewpoints.

COMMITTEE ON ARRANGEMENTS

Leland S. McKittrick Chairman	William E. Ladd
Richard H. Sweet Secretary	Frank H. Lahey
Arthur W. Allen	Donald Munro
Edward D. Churchill	Charles G. Mixter
Howard M. Clute	Frank R. Ober
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Elliott C. Cutler	George L. Tobey, Jr.
Frederick C. Irving	Frederick H. Verhoeff
	Irving J. Walker
	Shields Warren

The medical schools and their affiliated hospitals have expressed a willingness to plan a series of exhibits demonstrating their work in clinical investigation and the latest advances in surgical research. These exhibits will be available for study in the local hospitals during the entire meeting. The basic science departments of the medical schools will present important work related to surgical practice. Thus, the Boston institutions will have much to offer in the way of a highly concentrated practical postgraduate course in surgery and allied subjects. A preliminary clinical program appears in the following pages. The preliminary clinical program as published at this time is incomplete in that a number of hospitals that will participate in the clinical program are not included. Schedules for the following hospitals will appear when the clinical program is again published: Lakeville State Sanatorium, New England Hospital for Women and Children, Newton, and St. Elizabeth's.

The program of each hospital is arranged to cover subjects in general surgery, obstetrics and gynecology, fractures, orthopedic surgery, thoracic

surgery, neurosurgery, genito-urinary surgery, ophthalmology and otolaryngology. Thus the visiting surgeon may select the clinics which he wishes to attend. Presentation of subjects under these classifications will be so correlated that he will have the opportunity to devote his time continuously to clinics dealing with the specialty in which he is most interested. The daily clinical bulletin will present the program according to the above classification. The complete detailed clinical program for the succeeding day will be posted each afternoon in the form of bulletins at headquarters in the Statler Hotel and distributed in printed form each morning. The preliminary programs and the general program to be published later will include as much detailed information as it is possible to present in advance, but it will be necessary for those who attend the Congress to make their clinic ticket selections from the daily bulletins.

SCIENTIFIC SESSIONS

The opening scientific session of the Clinical Congress, the combined presidential meeting and convocation, will be held on Monday evening in Symphony Hall. At this session the new officers of the College will be inaugurated and the initiates received into fellowship. Dr. Evarts A. Graham, of St. Louis, will deliver the presidential address.

Eminent surgeons and specialists, recognized as authorities in their fields, will address the scientific meetings which will be held on Tuesday, Wednesday, and Thursday evenings in the ballroom of the Copley-Plaza Hotel. Special scientific meetings are being arranged for those who are interested in ophthalmology and otolaryngology on Tuesday, Wednesday, and Thursday evenings. The Board of Regents of the College is giving careful attention to the selection of the speakers and subjects for these evening sessions, so that a well rounded program introducing the newest developments in general and special fields may be assured.

During recent years, at both the Clinical Congress and sectional meetings of the College, panel discussions held at the headquarters hotel have created unusual interest. Therefore, a schedule of thirty or more of these sessions is being planned for Monday, Tuesday, Wednesday, and Thursday afternoons. These panels will be led by recognized authorities in each field who will have the aid of collaborators equally qualified to present fundamental facts on the chosen subject, and to direct the discussion in such a way that various viewpoints may be expressed. These sessions afford an opportunity for a large number of surgeons to participate and learn of the discoveries and experiences of others. The general plan is for a ten-minute presentation of the subject by the leader, collaborators to follow with brief discussions on different phases of the topic, following which general discussion from the floor will be the final and major feature of each session.

Because of the widespread interest in the special subjects, a symposium on fractures and other traumas is being planned for one afternoon, and a symposium on cancer for another afternoon. As in former years, these sessions are expected to attract a large attendance.

A new feature, introduced at the Clinical Congress in Chicago, and which proved popular, is again being planned for Friday afternoon. For these conferences ten special fields have been selected, and a pertinent subject of current interest will be briefly presented by a leader at each session. Discussion from the floor is directed by the leader and any surgeon attending is privileged to present a special problem related to the field under discussion with which he is concerned. Such opportunity for large groups of surgeons to participate in a consultation conference of this nature is apparently welcome.

The Board of Regents and the local committee aim to provide a varied type of program that will enable each individual surgeon to learn of the newer developments in many fields. The interests of both the general surgeon and the surgical specialists are being carefully considered in arranging all features of the program.

SPECIAL MEETING OF BOSTON SURGICAL SOCIETY

The Boston Surgical Society will hold a special meeting on the evening of Friday, November 7, in the ballroom of the Copley-Plaza Hotel, to which all fellows of the College and other surgeons attending the Clinical Congress are invited to be present. The occasion of this special meeting of the society is the presentation of the Bigelow Medal to Dr. Allen O. Whipple, of New York, for his outstanding contributions to the advancement of surgery.

MEDICAL MOTION PICTURES

The visual education aspects of the program of the Clinical Congress will again be enlarged with the aid of medical motion picture films. The latest available pictures showing surgical procedures and related subjects will be exhibited. The schedule will be arranged so as not to conflict with either the clinical program at the hospitals or the scientific sessions, and will include both sound and silent, standard and color films which have been approved by the Committee on Medical Motion Pictures.

HOSPITAL CONFERENCES

On Monday morning at 10 o'clock, in the Ballroom of the Copley-Plaza Hotel, the first session of the twenty-fourth annual HospitalStandardization Conference will open the Clinical Congress. At this session the 1941 list of approved hospitals, cancer clinics, and hospitals approved for graduate training in surgery and the surgical specialties will be officially announced. Dr. Evarts A. Graham, of St. Louis, president of the College, will preside. The hospital conference will continue on Monday afternoon in the same room, with sessions on Tuesday, Wednesday, and Thursday mornings, afternoons, and evenings. Programs are being arranged to interest hospital administrators, heads of various hospital departments and their personnel, nursing groups, and members of governing boards. One hospital conference in particular will be devoted exclusively to subjects of vital interest to members of governing boards. All aspects of the public relations problem will be discussed.

At a joint session with the Association of Record Librarians of North America, medical records will receive special consideration. National organizations representing various groups of hospital personnel will co-operate and participate in these meetings.

Some of the hospital conferences at the headquarters hotel will be formal sessions, others will be in the nature of panel discussions, round table conferences, and open forums. In certain sessions there will be a presentation of specific phases on a general theme by several speakers: in others a variety of subjects will be covered. The program will be developed to meet current needs, and from all indications is likely to emphasize from all angles the rôle of the hospital in the program of national defense.

As a special feature of the hospital conference it is planned to develop a program that will definitely appeal to the general surgeons and surgical specialists. This will take the form of a large general meeting with a series of panel discussions on appropriate subjects dealing with the care of patients, educational functions of the hospital, the control of surgery, and the clinical work in the related specialties. Organizations representing the specialty groups will be invited to participate in this phase of the program. Special consideration will be given in this series of meetings to the important subject of graduate training in general surgery and the surgical specialties. It is hoped that through this means the fellows of the College may become better acquainted with its extensive program of hospital activities which is aimed at improvement in the environment in which the surgeon is working.

PUBLICATION OF PROCEEDINGS

As in former years, the formal papers which are presented at the scientific sessions of the Congress will be presented in a special issue of the official journal of the College, SURGERY, GYNECOLOGY, AND OBSTETRICS, published in February following the meeting. This issue is furnished without additional charge to all fellows, junior candidates, and others who register for the Congress as invited guests. The papers which are presented in connection with the hospital standardization conference are published in subsequent issues of the *Bulletin* of the American College of Surgeons.

ADVANCE REGISTRATION

The hospitals and medical schools of the Boston area afford accommodations for a large number of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to the number that can be comfortably accommodated at the clinics. The limit of attendance will be based on a survey determining the available facilities in the participating hospitals and schools. It is expected, therefore, that surgeons who wish to attend the Congress will register in advance. A registration fee will be required in order to provide funds with which to meet expenses of the meeting. A formal receipt will be issued to each surgeon registering in advance, which will be exchanged for a general admission card upon presentation at headquarters during the Congress. This card, which is not transferable, must accompany all requests for clinic tickets and be presented for admission to the scientific sessions.

A resolution adopted by the Board of Regents provides that the registration fee for fellows of the College and endorsed junior candidates shall be $5.00; that no fee for the 1941 Clinical Congress shall be required of initiates (class of 1941); that the fee for surgeons who are not fellows, attending as invited guests of the College, shall be $10.00.

As in previous years, admission to clinics and demonstrations in the hospitals and certain of the scientific meetings at headquarters will be controlled by means of tickets. This plan provides for the distribution of visiting surgeons at the various clinics and other meetings, and helps to insure against overcrowding. The number of tickets issued for any clinic will be limited to the capacity of the room in which the clinic is held. Visiting surgeons are urged to co-operate in making the clinic ticket plan a success.

HEADQUARTERS AND TECHNICAL EXHIBITION

Headquarters for the Congress will be established at the Statler and Copley-Plaza Hotels where there are ample facilities for accommodating the Congress. All of the public rooms have been reserved for the exclusive use by the College during the five-day meeting. Registration for visiting surgeons and their ladies, the Technical Exhibition, executive offices of the College, and certain scientific sessions and medical motion picture exhibitions will be located in the Statler Hotel. Registration for those attending the hospital conference, exhibits of College activities, and the morning, afternoon, and evening hospital conferences will be located in the Copley-Plaza Hotel. The evening scientific sessions on Tuesday, Wednesday, and Thursday will also be held at the Copley-Plaza.

The Technical Exhibition, registration desk for attending surgeons, clinic ticket and information bureau will be located in the ballroom on the mezzanine floor of the Statler Hotel. Additional space for the exhibition will be provided in the Assembly Room and the mezzanine lounge adjacent to the ballroom. Leading manufacturers of surgical instruments and supplies, sutures, dressings, pharmaceuticals, operating room equipment, x-ray apparatus, hospital equipment of all kinds, and publishers of medical books will be represented in the exhibition. It will provide for the visiting surgeons and hospital people an opportunity of carefully inspecting the finest modern products of all those industries which are helping to improve the service of hospitals and surgeons.

BOSTON HOTELS AND THEIR RATES

In addition to the headquarters hotels, the Statler and Copley-Plaza, there are a number of first-class hotels within a short distance of headquarters. These will provide ample facilities at reasonable rates. It is suggested that reservations for hotel accommodations be made well in advance of the meeting. The following hotels are recommended by the Committee:

	Minimum Rates with Bath	
	Single	Double
Bellevue, 21 Beacon Street	$3.00	$4.50
Bradford, 275 Tremont Street	3.00	4.50
Brunswick, 520 Boylston Street	3.00	4.00
Buckminster, 645 Beacon Street	2.50	4.00
Copley-Plaza, 138 St. James Avenue	4.00	6.00
Copley Square, 47 Huntington Avenue	2.75	4.00
Kenmore, 490 Commonwealth Avenue	3.50	5.00
Lenox, Exeter Street	3.00	3.50
Lincolnshire, 20 Charles Street	3.00	5.00
Parker House, 60 School Street	3.50	5.00
Ritz-Carlton, 15 Arlington Street	5.00	8.00
Sheraton, 91 Bay State Road	3.00	5.00
Somerset, 400 Commonwealth Avenue	3.50	6.00
Statler, Park Square	3.50	5.00
Touraine, 62 Boylston Street	3.50	5.00
Vendome, 160 Commonwealth Avenue	3.00	4.00
Westminster, 124 St. James Avenue	2.50	4.00

PRELIMINARY CLINICAL PROGRAM

MASSACHUSETTS GENERAL HOSPITAL

Monday

GENERAL SURGERY

H. K. BEECHER and associates—2. Dry clinic: Anesthesia and related subjects.
H. K. BEECHER—2. Anesthesia for transpleural gastric surgery.
JULIA G. ARROWOOD and H. K. BEECHER—2:10. Fractional spinal.
H. K. BEECHER and R. A. ADAMS—2:25. Use of ether in the presence of pulmonary tuberculosis.
H. K. BEECHER—2:40. Anesthesia and shock.
E. B. BENEDICT—3:30. Endoscopy, bronchoscopy and esophagoscopy with special emphasis on the two newer endoscopic methods, gastroscopy and peritoneoscopy; demonstration with lantern slides and patients.
L. S. MCKITTRICK and associates—2. Symposium: Peripheral vascular clinic.
H. H. FAXON—2. Fundamental considerations, anatomy, physiology, etiology, examination.
R. H. THOMPSON—2:15. Late results following treatment uncomplicated varicose veins.
H. H. FAXON—2:30. Present concept of treatment.
R. R. LINTON—2:45. Chronic and recurrent ulceration of lower extremities, etiological factors and classification.
R. H. ADAMS—3:05. High division and injection of long saphenous veins; division of communicating veins with and without excision of fascia; excision and graft; results.
R. R. LINTON—3:30. Present concept of treatment.
H. H. FAXON, R. THOMPSON, R. R. LINTON, and R. H. ADAMS—4. Operations: Peripheral vascular.
Staff—2. Dry clinic: Tumors.

NEUROSURGERY

J. C. WHITE and associates—2. Symposium:
J. C. WHITE and J. J. MICHELSON—2. Operations.
W. J. MIXTER—4. Electro-encephalographic control of anticonvulsant therapy.
C. S. KUBIC and A. O. HAMPTON—4. Removal of lipiodol by lumbar puncture.
J. C. WHITE—4. Effect of anesthesia on volume of brain.

Tuesday

GENERAL SURGERY

A. W. ALLEN and associates—8. Symposium: Gastric lesions.
C. M. JONES—8. Medical considerations.
A. O. HAMPTON and associates—8:30. Roentgenological studies.
E. B. BENEDICT—8:50. Gastroscopy and peritoneoscopy.
C. E. WELCH—9:10. Gastric ulcer.
LANGDON PARSONS—9:30. Cancer of the stomach.
R. H. SWEET—9:50. Transthoracic gastrectomy.
A. W. ALLEN—10:10. Surgical procedures for gastric lesions.
Staff—10:30. Operative clinic: Gastric resections for benign and malignant lesions.
H. H. FAXON, HORATIO ROGERS, and associates—9–11. Symposium: Acute appendicitis.
HORATIO ROGERS. Present status; chief factors in present mortality rates, late diagnosis and/or treatment, faulty appraisal of individual patients, rigid policies of treatment, faulty technique, type of incision.
W. D. SMITH. Appendicitis in general medical practice.
HORATIO ROGERS. Appendiceal peritonitis before localization.
H. H. FAXON. Appendiceal peritonitis after localization.
CHAMP LYONS. The rôle of bacteriology and chemotherapy in appendicitis.
R. R. LINTON. Special aspects of appendicitis in young children.
Staff—11. Operative clinic: Acute appendicitis.
L. S. MCKITTRICK and associates—2. Symposium: Cancer of colon and rectum.
CHAMP LYONS and associates—2. Dry clinic: Surgical infections.

NEUROSURGERY

J. C. WHITE and associates—9. Operative and dry clinic:
W. J. MIXTER and J. S. HODGSON—9–11. Neurological operations.
J. C. WHITE—11–1. Presentation of operative results in angina pectoris and extra-pyramidal tremors.
J. J. MICHELSON—11–1. Treatment of torticollis by alcohol injection of cervical muscles.
J. C. WHITE and associates—2–4. Dry clinic:
W. J. MIXTER. Protrusion of nucleus pulposus in cervical spine.
J. S. HODGSON. Experience with cerebellar hemangiomas, Lindau's disease.
J. J. MICHELSON. Subdural abscess.
W. H. SWEET. New methods for measurement of blood flow.
J. C. WHITE. Spinothalamic tractotomy in the medulla.

Wednesday

GENERAL SURGERY

L. S. MCKITTRICK and associates—9. Operative and dry clinic: Ulcerative colitis.
C. M. JONES—9. Medical aspects, diagnosis and treatment.
L. S. MCKITTRICK—9:20. Surgical aspects, types of operations and indications.
JOHN D. STEWART—9:40. Ileostomy, operative technique, postoperative complications.
RICHARD H. WARREN—10:10. Late results after ileostomy, social and economic aspects.
L. S. MCKITTRICK—10:30. Colectomy, indications, technique, results.
Staff—11. Operative clinic.
H. C. MARBLE and associates—9. Symposium: Hand.
H. C. MARBLE. Anatomy and examination of the hand.
F. G. BALCH, JR. Tumors of the hand.
EDWARD HAMLIN, JR. Injuries to nerves of upper extremity.
W. BRADFORD CANNON. Skin grafts of the hand.
A. L. WATKINS, A. W. REGGIO, and H. C. MARBLE. Reconstruction of the hands, physiotherapy, occupational therapy, surgical reconstruction.
A. W. ALLEN and associates—2. Symposium: Diseases of the gall bladder and bile ducts.
A. W. ALLEN—2. Technical considerations of the gall bladder and bile ducts with special reference to morbidity and mortality.

RICHARD H. WALLACE—2:30. Acute cholecystitis.
JOHN D. STEWART—2:50. Obstructive jaundice, liver function, preparation of the patient, and after-care.
RICHARD H. WARREN—3:15. Carcinoma of the gall bladder.
Staff—3:30. Operations: Extra-hepatic biliary tract.

L. S. MCKITTRICK and associates—2. Symposium: Peripheral vascular disease.
L. S. MCKITTRICK—2. Fundamental considerations, classification, differential diagnosis.
EDWARD HAMLIN, JR.—2:15. Thrombo-angiitis obliterans. Outline of treatment, nerve crushing, mechanical aids, indications for amputation.
H. E. KENNARD—2:35. End-result study with particular reference to the economic aspect of the disease.
RICHARD H. WARREN—2:55. Arteriosclerotic gangrene with and without diabetes. Indications for and technique of minor amputation.
T. C. PRATT—3:10. Indications for and technique of supracondylar amputation.
R. H. SMITHWICK—3:30. Lumbar sympathectomy, its rôle in the treatment of obliterative disease; indications for operation and operative technique.
Staff—4. Operations: Supracondylar amputation for gangrene, nerve crushing for relief of pain, lumbar sympathectomy.

GENITO-URINARY SURGERY

G. G. Smith and associates—9. Operative and dry clinic:
Staff—9. Operations.
F. H. COLBY—10:30. Genito-urinary tuberculosis.
RICHARD CHUTE—10:50. Results of treatment with estrogenic substances in prostatic hypertrophy.
S. B. KELLEY—11:10. Complications of transurethral resection.
LORANDE WOODRUFF—11:40. The female urethra.

G. G. SMITH and associates—2. Operative and dry clinic:
Staff—2. Operations.
G. G. SMITH—3:30. Treatment of prostatic cancer.
ARTHUR WILLETS—3.50. Chronic prostatitis.
W. F. LEADBETTER—4:10. Renal arteriography.
JOHN P. GENS—4:30. The male hormone.

THORACIC SURGERY

E. D. CHURCHILL and associates—9. Symposium: Primary tumors of the lung and mediastinum.

Thursday

GENERAL SURGERY

A. W. ALLEN and associates—8. Symposium: Duodenal ulcer.
C. M. Jones and associates—8. Medical considerations.
A. O. HAMPTON and associates—8:30. Roentgenological diagnosis.
E. B. BENEDICT—8:50. Gastroscopy, gastritis.
A. W. ALLEN—9:10. Surgical considerations.
HOWARD ULFELDER—9:40. Acute perforation.
C. E. WELCH—10:10. Malfunction of anastomotic stoma and after-care.
Staff—10:30. Operations.

V. H. KAZANJIAN—8–12:30. Operative and dry clinic: Plastic surgery, presentation of cases operated upon for various deformities.

L. S. MCKITTRICK and associates—2. Operative and dry clinic: Acute small bowel obstruction.
RICHARD H. WARREN—2. Physiological aspects of non-strangulation obstruction, cause of death.
L. S. MCKITTRICK—2:20. Factors influencing mortality rate.
S. P. SARRIS—2:40. Diagnosis.
RICHARD H. WARREN—3:10. Non-operative treatment, practical considerations in the use of Miller-Abbott tube.
L. S. MCKITTRICK—3:30. Résumé, outline of treatment, results.
Staff—4. Operations.

GENITO-URINARY SURGERY

G. G. SMITH and associates—9. Operative and dry clinic:
G. G. SMITH and associates—9. Operations.
HOWARD I. SUBY—10:30. The solution of urinary calculi.
RICHARD CHUTE—10:50. Problems in the treatment of urinary calculi.
F. H. COLBY—11:15. Deep x-ray therapy in cancer of the bladder.
S. B. KELLEY—11:40. Ureterostomy versus nephrostomy.

THORACIC SURGERY

E. D. CHURCHILL and associates—2. Symposium: Suppurative disease of the lung.

ORTHOPEDIC SURGERY

M. N. SMITH-PETERSEN and associates—2. Operative and dry clinic.

Friday

GENERAL SURGERY

E. D. CHURCHILL and associates—9. Operative and dry clinic: Parathyroid tumors.

L. S. MCKITTRICK and associates—2. Symposium: Peripheral vascular disease.
RICHARD H. WARREN—2. Fundamental considerations of thrombus formation, clinical manifestations, diagnosis and treatment.
H. H. FAXON—2:20. Pulmonary embolism, its relation to venous thrombosis.
RICHARD H. WARREN—2:45. Use of heparin in prevention of pulmonary emboli.
C. E. WELCH and C. E. MCGAHEY—3. Venography, indications, technique, results.
H. H. FAXON—3:15. Exploration and division of the femoral vein, indications and operative technique.
C. E. WELCH—3:35. Results, early and late, after division of the femoral vein.
H. H. FAXON, C. E. WELCH, and RICHARD H. WARREN—4. Operations.

R. H. SMITHWICK and associates—2. Symposium: Surgery of hypertension, non-nephritic.
ROBERT S. PALMER. Statement of the problem.
BENJAMIN CASTLEMAN. Renal pathology.
JOHN H. TALBOT. Renal physiology.
RICHARD CHUTE. Urological factors.
R. H. SMITHWICK. Modification of abnormal physiology by sympathectomy.

OBSTETRICS AND GYNECOLOGY

J. V. MEIGS and associates—9. Symposium: Gynecological problems.
J. V. MEIGS, LANGDON PARSONS, and MARSHALL K. BARTLETT—9–10:30. Operations.
J. V. MEIGS and associates—10:30–12. Discussion and demonstrations.

ORTHOPEDIC SURGERY

M. N. SMITH-PETERSEN and associates—9. Operative and dry clinic.

BOSTON CITY HOSPITAL

Monday

GENERAL SURGERY

Staff—2. Symposium: Vascular diseases.
E. E. O'Neil. Refrigeration in gangrene of lower extremities.
E. A. Edwards. Thrombophlebitis in unusual forms.
S. J. G. Nowak. Experimental hypertension.
D. C. Goldfarb. False aneurysm of femoral artery.
T. Leary. Pathological aspects of vascular disease.
E. E. O'Neil. Lumbar sympathectomy for vascular disease.

Tuesday

GENERAL SURGERY

Staff—2. Dry clinic:
W. R. Morrison. Gastrojejunocolonic fistula.
C. W. McClure. Gastroscopy, kodachrome pictures.
I. C. Walker. Bleeding peptic ulcers.
A. R. Kimpton. Cancer of stomach.
W. R. Morrison. Perforated peptic ulcer.
E. E. O'Neil. Transpleural approach for carcinoma of upper end of stomach.
T. W. Wickham. Cholecystitis and its relation to peptic ulcer.

OBSTETRICS AND GYNECOLOGY

Staff—2. Symposium: Pregnancy, the physiological and pathological aspects.
George R. Minot and Eugene L. Lozner. The hemorrhagic diatheses complicating pregnancy.
Frederick J. Lynch. Treatment of miscarriage.
Frederick Parker, Jr. Pathology of toxemia of pregnancy with especial reference to changes in the placenta.
Carmi R. Alden. Disorders of the urinary tract encountered in obstetrics.
Benedict F. Boland. Hormonal relationship between the kidneys and toxemia of pregnancy.
Maxwell Finland. Pneumonia in pregnancy.

FRACTURES AND OTHER TRAUMAS

Otto J. Hermann and associates—9. Symposium: Fractures of the ankle.
Otto J. Hermann. Introduction.
Gordon M. Morrison. Simple unilateral ankle injuries with fracture.
Joseph Burnett, G. G. Bailey, Joseph Shortell, and Russell Sullivan. Complicated ankle fractures, bilateral, following Cotton's therapeutic ankle classifications. Slides, charts, individual cases, and apparatus illustrate various points in this symposium.

OPHTHALMOLOGY

James J. Regan and staff—9. Symposium: Abnormal fundi.

OTORHINOLARYNGOLOGY

Staff—9. Dry clinic:
H. F. Friedman. Septic thrombophlebitis of frontal veins, with abscess formation.
E. J. Monahan. A method for the extirpation of branchial cysts.
Oscar Hirsch. Surgical removal of pituitary tumor via transnasal route.
Louis M. Freedman. Bronchoscopic treatment of pulmonary atelectasis.
Chester R. Mills. Osteomyelitis of the frontal bone.
Benjamin Riseman. Gumma of nasopharynx and lung.
Samuel W. Garfin. Treatment of fractures of the jaw.
Philip E. A. Sheridan, Charles DeWolfe, and Frederick Heimlick. Presentation of cases.

Wednesday

GENERAL SURGERY

Staff—9. Dry clinic:
Department of Pathology: Splenogenic myeloid metaplasia; argentophil tumors (carcinoid.)
Dr. Joliff. Surgical treatment of myeloma.
F. W. O'Brien. Cancer and x-ray therapy.
E. A. Cooney. Carcinoma of breast.
A. R. Kimpton. Cancer of large intestine.
Charles Lund. Cancer of mouth.
I. C. Walker. Cancer of stomach.
Staff—2. Symposium: Thyroid disease.
R. C. Cochrane. Tumors of parathyroid with lantern slides.
D. D. Berlin. Hyperthyroidism with cancer of thyroid.
W. T. Salter. Graves' disease without hypertension.
Richard Smith. Adenoma of thyroid.
R. C. Cochrane. Complication of thyroidectomy.
Staff—2. Symposium: Vitamins in surgery.
Charles Lund and J. H. Crandon. Vitamin C and wound healing.
Walter Wegner and Merrill Moore. Vitamins in presence of head injuries.
Dr. Mikeljohn. Presentation of cases.
Staff—2. Symposium:
Gordon M. Morrison. Radial nerve injury with fracture of humerus.
J. E. Flynn. Anatomical and clinical investigations of deep fascial space abscess of the hand.
T. K. Richards. Traumatic injuries of the knee joint.
J. E. Flynn. Dupuytren's contracture.
A. P. Aitken. Epiphyseal separation.
J. E. Flynn. Treatment of traumatic lesions of the hand.
Robert Ulin. Club-feet.

OBSTETRICS AND GYNECOLOGY

Staff—9. Dry clinic:
Speaker to be announced. Anesthesia and analgesia with special reference to spinal and intravenous anesthesia.
Dr. Reginald and R. D. Margeson. Placenta previa in patients previously delivered by low transverse cesarean section.
Frederick L. Good. Physiology of lower uterine segment.
Daniel J. McSweeney. Radiographic pelvimetry.
Staff—9. Dry clinic:
F. W. O'Brien. Results in treatment of carcinoma of the uterus in the tumor clinic of a general hospital.
Frederick Parker, Jr. and John T. Williams. Pathology of so-called fibrosis of the uterus.

Thursday

GENERAL SURGERY

Otto J. Hermann and associates—9. Symposium: Low back pain.
Otto J. Hermann. Introduction.
John T. Williams. Gynecological aspects.
Augustus Riley. Genito-urinary aspects.
Robert Ulin. A rational method of routine back examination based on anatomical and physiological factors.
Joseph Shortell. Low back pain with negative x-ray,

lumbosacral, sacro-iliac, myositis, myositis-fascitis, industrial postural, mechanical findings.
THOMAS H. PETERSON. Coccygodynia, fracture of coccyx, conservatism vs. surgery in treatment.
RUSSELL SULLIVAN. Anatomical abnormalities of the fifth lumbar vertebra and lumbosacral joint.
G. KENNETH COONSE. Spondylolisthesis: Pathology, diagnostic points, rôle of trauma in its production, and treatment.
A. P. AITKEN. Fascial contractions.
MARK H. ROGERS. Orthopedic aspect, intervertebral disc problem.
P. F. BUTLER. Intervertebral disc problem, x-ray aspect.
DONALD MUNRO. Intervertebral disc problem, neurological aspect.
Staff—2. Symposium: Appendicitis, biliary system, and hernia.
P. S. FOISIE. Appendicitis and complications.
G. W. PAPEN. Incision for appendectomy in extreme obesity.
T. W. WICKHAM. Analysis of 600 cholecystectomies.
F. F. HENDERSON and JOHN MCGOWAN. Operative biliary drainage for relief of jaundice; operative care of gall-bladder patient.
J. J. HEPBURN. Familial hemolytic jaundice and splenectomy.
W. R. MORRISON. Stones of the hepatic ducts; subdiaphragmatic abscess.
CHARLES LAMB. Peritoneoscopy with especial reference to biliary disease.
RICHARD SMITH. Exteriorization of small intestines in strangulated hernia.
D. C. GOLDFARB. Recurrent inguinal hernia.
Staff—2. Symposium: Anesthesia, large intestine, and other abdominal surgery.
T. W. WICKHAM. Foci of infection and ulcerative colitis.
A. R. KIMPTON. Surgery of large intestine.
J. EDWARD FLYNN. Abdominoperineal resection of rectum for carcinoma with abscess formation.
C. W. MCCLURE. Signoidoscopy, kodachrome pictures.
FRANK MARVIN. Indications and contra-indications for various anesthetics.
S. C. WIGGIN. Spinal anesthesia.
G. C. MOORE. Intravenous anesthesia.
P. S. FOISIE. Ruptured corpus hemorrhagicum.
ALLEN DAVIS. Calcified cyst of spleen.
S. J. MADDOCK. High and low intestinal obstruction.
ALLEN DAVIS. Gun shot wounds of abdomen.
HALSEY B. LODER. Postoperative treatment.

GENITO-URINARY SURGERY

Staff—9. Symposium:
H. H. HOWARD. Epidermoid carcinoma of the penis.
GEORGE C. PRATHER. Stricture of the urethra.
S. R. MUELLNER. Newer concepts of urinary extravasation.
G. D. ATKINSON. Scrotal plastics after idiopathic gangrene.
W. H. HOLTHAM. Treatment of gonorrheal urethritis with sulfathiazole.
J. A. SETH. Removal of calculi from lower ureter by the vaginal route, report of 2 cases.
F. G. SHEDDAN. Fracture of the penis, case report; anatomical study of remnants of prostate tissue in the prostatic bed following enucleation.
AUGUSTUS RILEY. Hemangioma of kidney; case report.

OPHTHALMOLOGY

JAMES J. REGAN and staff—9. Operations.

Friday

GENERAL SURGERY

Staff—2. Symposium:
C. G. SHEDD. Chemotherapy in general peritonitis.
MAXWELL FINLAND. Chemotherapy in surgery.
R. H. ALDRICH. The dymixal treatment of burns with especial reference to shock.
H. G. DUNPHY. "Z" plastics in burns.

THORACIC SURGERY

Staff—9. Symposium:
J. W. STRIEDER. Suppurative pericarditis, colored motion pictures; putrid empyema, result of modern method of treatment; lobectomy for bronchiectasis.
HORACE BINNEY. Methods and results of treatment of pulmonary tuberculosis.
S. J. G. NOWAK. Experimental pulmonary embolus.
DR. SHULTZ. Intratracheal anesthesia for thoracic surgery.

ORTHOPEDIC SURGERY

Staff—9. Symposium: Fractures of the hip.
NEWTON C. BROWDER. Intracapsular fractures of the hip.
RUSSELL SULLIVAN. Hip fractures, cases of operative reduction and internal fixation.
OTTO J. HERMANN. Painful un-united hip fractures.
THOMAS H. PETERSON. Posterior fusion of the hip.
A. A. THIBODEAU. Slipped femoral epiphysis.
JAMES W. SEVER. Presentation of cases.

FREE HOSPITAL FOR WOMEN

Tuesday

OBSTETRICS AND GYNECOLOGY

Staff—9. Symposium: Carcinoma of the cervix.
FRANK A. PEMBERTON—9. Operation: Radium application.
ARTHUR T. HERTIG and PAUL A. YOUNGE—9:30. Diagnosis of early carcinoma.
PAUL A. YOUNGE—10. Management of the urological complications.
GEORGE VAN S. SMITH—10:30. Results.

Wednesday

OBSTETRICS AND GYNECOLOGY

Staff—9. Symposium: Cancer of the endometrium.
FRANK A. PEMBERTON—9. Operation: Hysterectomy for carcinoma of endometrium.
ARTHUR T. HERTIG—10. Pathology.
GEORGE VAN S. SMITH—10:30. Results.

Thursday

OBSTETRICS AND GYNECOLOGY

GEORGE VAN S. SMITH, JOHN ROCK, and associates—9. Symposium: Fertility, hormones in gynecology.

Friday

OBSTETRICS AND GYNECOLOGY

Staff—9. Symposium: Tumors of the ovary.
GEORGE VAN S. SMITH—9. Operation: Cancer of ovary.
ARTHUR T. HERTIG—10. Pathology.
FRANK A. PEMBERTON—10:45. Results.
SIDNEY C. GRAVES—11. Kraurosis of the vulva.

PETER BENT BRIGHAM HOSPITAL

Tuesday

GENERAL SURGERY

ELLIOTT C. CUTLER and ROBERT E. GROSS—9. Operations: Ligation of patent ductus arteriosus; pericardiectomy.

ELLIOTT C. CUTLER and associates—10. Symposium: Surgery of the heart and blood vessels.

C. SIDNEY BURWELL. Forms of heart disease amenable to surgery.

SAMUEL A. LEVINE. Cardiac disease simulating surgical conditions of the abdomen and vice versa.

EUGENE C. EPPINGER. Indications for surgery for patent ductus arteriosus.

ROBERT E. GROSS. Surgical treatment of patent ductus arteriosus.

ELLIOTT C. CUTLER. The technique of pericardiectomy.

MERRILL C. SOSMAN. The rôle of the roentgenologist in cardiac surgery.

JOHN HOMANS. Peripheral vascular disease.

MARSHALL N. FULTON. Angiomas of skeletal muscle.

DAVID CHEEVER—2. Dry clinic: Surgical anatomy of the abdomen.

Wednesday

GENERAL SURGERY

ELLIOTT C. CUTLER and ROBERT ZOLLINGER—9. Operations: Gastric resections.

ELLIOTT C. CUTLER and associates—10. Symposium: Gastric and duodenal ulcer.

ELLIOTT C. CUTLER. Indications for surgery with gastric and duodenal ulcer.

EDWARD S. EMERY, JR. Medical management of bleeding peptic ulcer.

MERRILL C. SOSMAN. Significance of prepyloric ulcer.

HARRY A. WARREN. Duodenal diverticulum.

ROBERT ZOLLINGER. Surgical treatment of severe duodenal ulcer.

ELLIOTT C. CUTLER. Results of acute gastroduodenal perforation.

CARL W. WALTER—2. Symposium: Aseptic technique.

Thursday

GENERAL SURGERY

FRANCIS C. NEWTON and J. ENGLEBERT DUNPHY—9. Operations: Colon, rectum and anus.

ELLIOTT C. CUTLER and associates—10. Symposium: Colon, rectum and anus.

FRANCIS C. NEWTON. Experiences with cancer of the colon.

J. ENGLEBERT DUNPHY. Experiences with anterior resection for cancer of the rectosigmoid.

ANDREW W. CONTRATTO and THOMAS B. QUIGLEY. Differential diagnosis of gastritis and gastro-enteritis from appendicitis.

MERRILL C. SOSMAN. The x-ray and large bowel surgery.

EDWARD S. EMERY, JR. Medical diseases of the colon.

ELLIOTT C. CUTLER. Cicatrizing enteritis.

GENITO-URINARY SURGERY

WILLIAM C. QUINBY and associates—2. Symposium:

J. HARTWELL HARRISON. The diagnosis and treatment of common injuries of the urinary tract.

GEORGE AUSTEN. A correlation of the clinical aspects and pathology of the fused renal mass.

G. PHILIP GRABFIELD. Renal blood flow.

F. ANTHONY SIMEONE. Experimental hypertension.

WILLIAM C. QUINBY. A critical evaluation of prostatic surgery in recent years.

Friday

GENERAL SURGERY

ELLIOTT C. CUTLER and ROBERT ZOLLINGER—9. Operations: Cholecystectomy, choledochostomy.

ELLIOTT C. CUTLER and associates—10. Symposium: Surgical diseases of the biliary tract.

ELLIOTT C. CUTLER. Biliary calculus, technique of surgical therapy.

MERRILL C. SOSMAN. Upright films of the gall bladder as an aid in the diagnosis of cholelithiasis.

ROBERT ZOLLINGER. Acute cholecystitis.

THOMAS B. QUIGLEY. Surgery of the biliary tract in the aged.

WILLIAM A. DAVIS. Clinical use of vitamin K in surgery of the biliary tract.

EDWARD S. EMERY, JR. Medical treatment after cholecystectomy.

ELLIOTT C. CUTLER and associates—2. Symposium: Surgical treatment of hyperthyroidism.

ELLIOTT C. CUTLER. The domain of thyroid surgery.

SAMUEL A. LEVINE. Pre-operative and postoperative treatment of severe thyrocardiacs.

MARSHALL N. FULTON. Recurrent hyperthyroidism.

J. ENGLEBERT DUNPHY. Use of silk in surgery of the thyroid.

HARRY B. FRIEDGOOD. Rôle of the pituitary hormone in thyrotoxicosis.

ELLIOTT C. CUTLER. Technique of thyroidectomy.

BOSTON LYING-IN HOSPITAL

Tuesday

OBSTETRICS AND GYNECOLOGY

Staff—10. Operative and dry clinic:

CHARLES A. JANEWAY. Treatment of puerperal sepsis with sulfanilamide and immune transfusions.

CLEMENT A. SMITH. Effect of various anesthetics as shown by blood gas determinations on mothers and their infants.

Wednesday

OBSTETRICS AND GYNECOLOGY

Staff—2. Dry clinic:

MEINOLPH V. KAPPIUS. The rôle of soft tissue x-ray technique in the diagnosis of placenta previa.

ROBERT N. RUTHERFORD. Interpretation of bleeding in the first trimester of pregnancy as shown by endometrial biopsies.

ARTHUR T. HERTIG. Pathological ova, chief cause of spontaneous abortion.

ROBERT H. BARKER. Determination of cephalopelvic disproportion by the Thoms method of roentgenometry.

Thursday

OBSTETRICS AND GYNECOLOGY

Staff—10. Operative and dry clinic:

JOHN L. NEWELL. External cephalic version as prophylaxis against the fetal hazards of breech presentations.

DANIEL ABRAMSON. End-results of a conservative policy at delivery as shown in a study of postpartum patients.

NEW ENGLAND DEACONESS HOSPITAL

Monday

GENERAL SURGERY

H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations and symposium: Anesthesia.

THORACIC SURGERY

H. D. ADAMS—2. Operations.

NEUROSURGERY

GILBERT HORRAX—1:30. Operations.

OTORHINOLARYNGOLOGY

F. D. LATHROP—1:30. Operations.

Tuesday

GENERAL SURGERY

F. H. LAHEY, R. B. CATTELL, S. F. MARSHALL, and B. P. COLCOCK—9. Operative clinic: Thyroid, stomach, colon, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—9. Anesthesia demonstrations: Regional, spinal, continuous spinal, and general.
H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.
F. H. LAHEY, LEWIS M. HURXTHAL, ELMER C. BARTELS, and H. J. PERKIN—2. Dry clinic: Symposium on thyroid surgery.

GENITO-URINARY SURGERY

E. E. EWERT and VERNON S. DICK—9. Operations.

THORACIC SURGERY

RICHARD H. OVERHOLT and R. H. BETTS—10. Dry clinic.
H. D. ADAMS—1:30. Operations.

NEUROSURGERY

J. L. POPPEN—9. Operations.
GILBERT HORRAX—1:30. Operations.

ORTHOPEDIC SURGERY

G. E. HAGGART and J. W. TOUMEY, JR.—9. Operations.

OTORHINOLARYNGOLOGY

WALTER B. HOOVER—9. Operations.
F. D. LATHROP—1:30. Operations.

Wednesday

GENERAL SURGERY

F. H. LAHEY, R. B. CATTELL, S. F. MARSHALL, and B. P. COLCOCK—9. Operative clinic: Thyroid, stomach, colon, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—9. Anesthesia demonstrations: Regional, spinal, continuous spinal, and general.
H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.
R. B. CATTELL, N. W. SWINTON, and EVERETT D. KIEFER—2. Dry clinic: Symposium on colon and rectal surgery.

GENITO-URINARY SURGERY

HARVARD H. CRABTREE—9. Operations.
E. E. EWERT and VERNON S. DICK—9. Operations.

THORACIC SURGERY

H. D. ADAMS—1:30. Operations.

NEUROSURGERY

J. L. POPPEN—9. Operations.
GILBERT HORRAX—1:30. Operations.

ORTHOPEDIC SURGERY

G. E. HAGGART and J. W. TOUMEY, JR.—9. Operations.

OTORHINOLARYNGOLOGY

WALTER B. HOOVER—9. Operations.
F. D. LATHROP—1:30. Operations.

Thursday

GENERAL SURGERY

F. H. LAHEY, R. B. CATTELL, S. F. MARSHALL, and B. P. COLCOCK—9. Operative clinic: Thyroid, stomach, colon, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—9. Anesthesia demonstrations: Regional, spinal, continuous spinal, and general.
H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.
F. H. LAHEY, SARA M. JORDAN, and S. F. MARSHALL—2. Symposium on gastric, duodenal, and jejunal surgery.

GENITO-URINARY SURGERY

E. E. EWERT and VERNON S. DICK—9. Operations.

NEUROSURGERY

J. L. POPPEN—9. Operations.

ORTHOPEDIC SURGERY

G. E. HAGGART and J. W. TOUMEY, JR.—9. Operations.

OTORHINOLARYNGOLOGY

WALTER B. HOOVER—9. Operations.

Friday

GENERAL SURGERY

F. H. LAHEY, R. B. CATTELL, S. F. MARSHALL, and B. P. COLCOCK—9. Operative clinic: Thyroid, stomach, colon, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—9. Anesthesia demonstrations: Regional, spinal, continuous spinal, and general.
H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.

GENITO-URINARY SURGERY

E. E. EWERT and VERNON S. DICK—9. Operations.

THORACIC SURGERY

RICHARD H. OVERHOLT and R. H. BETTS—10. Dry clinic.
H. D. ADAMS—1:30. Operations.

NEUROSURGERY

J. L. POPPEN—9. Operations.
GILBERT HORRAX—1:30. Operations.

ORTHOPEDIC SURGERY

G. E. HAGGART and J. W. TOUMEY, JR.—9. Operations.

OTORHINOLARYNGOLOGY

WALTER B. HOOVER—9. Operations.
F. D. LATHROP—1:30. Operations.
WALTER B. HOOVER—1:30. Dry clinic: Local anesthesia in surgery of nose and throat, method used in tonsillectomy, adenoidectomy, lingual tonsillectomy, and excision of lateral pharyngeal bands; septum; sinus surgery including Caldwell-Luc, external frontal, intranasal surgery; plastic procedures on external nose; disease of the esophagus, summary of symptoms, diagnosis and treatment of carcinoma, esophageal diverticulum, cardiospasm, esophagitis, ulcers, strictures of esophagus, and perforation; thyroid disease in the larynx; laryngeal paralysis.

NEW ENGLAND BAPTIST HOSPITAL

Monday

GENERAL SURGERY

H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic. Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.

THORACIC SURGERY

H. D. ADAMS—1:30. Operations.

NEUROSURGERY

GILBERT HORRAX—1:30. Operations.

OTORHINOLARYNGOLOGY

F. D. LATHROP—1:30. Operations.

Tuesday

GENERAL SURGERY

F. H. LAHEY, R. B. CATTELL, S. F. MARSHALL, and B. P. COLCOCK—9. Operative clinic: Thyroid, stomach, colon, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—9. Anesthesia demonstrations: Regional, spinal, continuous spinal, and general.
H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.

GENITO-URINARY SURGERY

E. E. EWERT and VERNON S. DICK—9. Operations.

THORACIC SURGERY

H. D. ADAMS—1:30. Operations.

NEUROSURGERY

J. L. POPPEN—9. Operations.
GILBERT HORRAX—1:30. Operations.

ORTHOPEDIC SURGERY

G. E. HAGGART and J. W. TOUMEY, JR.—9. Operative clinic.

OTORHINOLARYNGOLOGY

WALTER B. HOOVER—9. Operations.
F. D. LATHROP—1:30. Operations.

Wednesday

GENERAL SURGERY

F. H. LAHEY, R. B. CATTELL, S. F. MARSHALL, and B. P. COLCOCK—9. Operative clinic: Thyroid, stomach, colon, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—9. Anesthesia demonstrations: Regional, spinal, continuous spinal, and general.
H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.

GENITO-URINARY SURGERY

E. E. EWERT and VERNON S. DICK—9. Operations.

THORACIC SURGERY

H. D. ADAMS—1:30. Operations.

NEUROSURGERY

J. L. POPPEN—9. Operations.
GILBERT HORRAX—1:30. Operations.

ORTHOPEDIC SURGERY

G. E. HAGGART and J. W. TOUMEY, JR.—9. Operative clinic.

OTORHINOLARYNGOLOGY

WALTER B. HOOVER—9. Operations.
F. D. LATHROP—1:30. Operations.

Thursday

GENERAL SURGERY

F. H. LAHEY, R. B. CATTELL, S. F. MARSHALL, and B. P. COLCOCK—9. Operative clinic: Thyroid, stomach, colon, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—9. Anesthesia demonstrations: Regional, spinal, continuous spinal, and general.
H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.

GENITO-URINARY SURGERY

E. E. EWERT and VERNON S. DICK—9. Operations.

THORACIC SURGERY

H. D. ADAMS—1:30. Operations.

NEUROSURGERY

J. L. POPPEN—9. Operations.
GILBERT HORRAX—1:30. Operations.

ORTHOPEDIC SURGERY

G. E. HAGGART and J. W. TOUMEY, JR.—9. Operative clinic.

OTORHINOLARYNGOLOGY

WALTER B. HOOVER—9. Operations.
F. D. LATHROP—1:30. Operations.

Friday

GENERAL SURGERY

F. H. LAHEY, R. B. CATTELL, S. F. MARSHALL, and B. P. COLCOCK—9. Operative clinic: Thyroid, stomach, colon, and biliary tract.

U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—9. Anesthesia demonstrations: Regional, spinal, continuous spinal, and general.
H. D. ADAMS and N. W. SWINTON—1:30. Operative clinic: Thyroid, stomach, colon, rectum, and biliary tract.
U. H. EVERSOLE, LEO V. HAND, and M. J. NICHOLSON—1:30. Demonstrations: Anesthesia.

GENITO-URINARY SURGERY

E. E. EWERT and VERNON S. DICK—9. Operations.

THORACIC SURGERY

H. D. ADAMS—1:30. Operations.

NEUROSURGERY

J. L. POPPEN—9. Operations.
GILBERT HORRAX—1:30. Operations.

ORTHOPEDIC SURGERY

G. E. HAGGART and J. W. TOUMEY, JR.—9. Operative clinic.

OTORHINOLARYNGOLOGY

WALTER B. HOOVER—9. Operations.
F. D. LATHROP—1:30. Operations.

PALMER MEMORIAL HOSPITAL

Monday

GENERAL SURGERY

Staff—2. Symposium: Carcinoma of the breast.
CLIFFORD C. FRANSEEN. End-results of surgical treatment.
L. S. MCKITTRICK. Interstitial irradiation treatment of carcinoma of the breast with platinum radium needles.
J. H. MARKS. X-ray therapy of carcinoma of the breast.
SHIELDS WARREN. Relation between chronic cystic mastitis and carcinoma of the breast.

Tuesday

OBSTETRICS AND GYNECOLOGY

G. A. LELAND, JR., and C. J. SWAN—2. Symposium: Treatment of carcinoma of the cervix.

Wednesday

GENERAL SURGERY

Staff—2. Symposium: Carcinoma of the rectum and anus.
L. S. MCKITTRICK. Choice of operation in cases of carcinoma of the rectum.
W. F. LEADBETTER. Urological complications after excision of the rectum.
L. S. MCKITTRICK. Treatment of carcinoma of the rectum in poor-risk cases with electrocoagulation and radium implantation.
J. H. MARKS. X-ray therapy of carcinoma of the rectum.
R. H. SWEET. Carcinoma of the anal canal.
R. H. SWEET or CLIFFORD C. FRANSEEN. End-results of treatment of carcinoma of the rectum.

Friday

GENERAL SURGERY

Staff—2. Symposium: Diabetic gangrene.
H. F. ROOT. Medical aspects.
L. S. MCKITTRICK. Principles of surgical treatment, classification of lesions, conservative methods.
T. C. PRATT. Indications for and technique of minor amputation.
L. S. MCKITTRICK. Indications for and technique of major amputation.
T. C. PRATT. End-result study of 100 patients after supracondylar amputation for gangrene.
L. S. MCKITTRICK and T. C. PRATT. Operations: Supracondylar amputations for gangrene.

CARNEY HOSPITAL

Tuesday

OBSTETRICS AND GYNECOLOGY

LOUIS E. PHANEUF and associates—9. Operative clinic.
LOUIS E. PHANEUF and associates—2. Dry clinic.

Wednesday

GENERAL SURGERY

WILLIAM E. BROWNE, W. R. MACAUSLAND, ROGER C. GRAVES, and A. MCK. FRASER—9. Operations.
Staff—2. Dry clinic.

GENITO-URINARY SURGERY

Staff—2. Dry clinic.

ORTHOPEDIC SURGERY

Staff—2. Dry clinic.

Thursday

GENERAL SURGERY

WILLIAM E. BROWNE, W. R. MACAUSLAND, ROGER C. GRAVES, and A. MCK. FRASER—9. Operations.
Staff—2. Dry clinic.

GENITO-URINARY SURGERY

Staff—2. Dry clinic.

ORTHOPEDIC SURGERY

Staff—2. Dry clinic.

Friday

GENERAL SURGERY

WILLIAM E. BROWNE, W. R. MACAUSLAND, ROGER C. GRAVES, and A. MCK. FRASER—9. Operations.

ROBERT BRECK BRIGHAM HOSPITAL

Wednesday

ORTHOPEDIC SURGERY

Staff—2. Symposium: End-results on rehabilitation of chronic arthritis, prevention of deformities and early rehabilitation, results in correction of flexion deformity of knee, arthroplasty in upper extremity, operative correction of arthritic disabilities of the foot.

Days to be Announced

ORTHOPEDIC SURGERY

Staff—9. Operative clinic: Posterior capsuloplasty for correction of flexion deformity of knee; arthroplasty of elbow for ankylosis.

BETH ISRAEL HOSPITAL

Tuesday

GENERAL SURGERY

Staff—9. Dry clinic:
ARNOLD STARR. Biliary tract disease, left-sided pain.
C. G. MIXTER. Technique of immediate cholangiography motion pictures.
A. L. HERMANSON. Cholangiography, indications for and end-results.
H. A. FRANK. Advantages of intravenous synthetic vitamin K over other vitamin K preparations.
A. M. SELIGMAN. Vitamin P in capillary fragility.
Staff—10:30. Operative clinic:
C. G. MIXTER. Cholecystectomy and cholangiography.
JACOB FINE. Cholecystectomy, transverse incision.
L. H. NASON. Peritoneoscopy, spinal anesthesia.
ARNOLD STARR. Peritoneoscopy, local anesthesia.
Staff—2. Dry clinic:
MAX DAVIS. Ovarian tumors with endocrine effects.
R. B. DAVIDOFF. Relationship of cystic disease of the breast to disease of the uterus and adnexa.
A. L. HERMANSON. Comparative merits of the vaginal smear and endometrial biopsy in diagnosis of ovarian function.
S. L. GARGILL. Hyperparathyroidism.
D. D. BERLIN. Carcinoma of the thyroid.
M. F. LESSES. Complications of thyroid surgery.
S. L. GARGILL. Management of recurrent and persistent thyrotoxicosis.
D. D. BERLIN. The avoidance of complications in thyroid surgery.

GENITO-URINARY SURGERY

Staff—9. Dry clinic:
E. G. CRABTREE. Pre-operative preparation of prostatic cases.
G. C. PRATHER and M. L. BRODNY. Accessory bladder pathology in prostatic cases.
G. C. PRATHER and DR. REICH. Accessory renal pathology in prostatic cases.
E. G. CRABTREE. Summary of 12 years' experience in prostatic surgery.
G. C. PRATHER. Results of contact therapy for bladder tumors.
E. G. CRABTREE—10:45. Operation: Bladder tumor, contact radiation therapy.
Staff—2. Dry clinic:
E. L. PRIEN. Adaptation of the Tratner hydrophorograph for bladder studies.
DR. ZIMMERMAN. Bladder atonies.
J. H. LIPTON. Bladder atonies as demonstrated by the Tratner hydrophorograph.
S. R. MUELLNER. Testosterone effect on bladder tone; diabetic atony of the bladder.
B. E. GREENBERG. Value of cholinergic and adrenergic drugs in bladder atonies.
H. A. KONTOFF. Rate of recovery of bladder after relief of obstruction.
S. R. MUELLNER. Stress incontinence in the female.
E. L. PRIEN. Crystallography of the sulfonamide drugs.

Wednesday

GENERAL SURGERY

Staff—9. Dry clinic:
L. H. NASON. Pressure treatment of keloids.
J. B. SEARS. Prophylaxis of pulmonary embolism by division of femoral vein.
OSCAR HIRSCH. Changes in volume of the peritoneal cavity following intercostal nerve paralysis.
C. G. MIXTER. Giant hernia.
ARNOLD STARR. Advanced regional ileitis.
C. G. MIXTER. Transverse ileocolostomy with or without resection for regional ileitis.
Staff—10:30. Operative clinic:
C. G. MIXTER. Intestinal resection.
J. B. SEARS. Division of femoral vein for treatment of non-fatal pulmonary embolus.
D. D. BERLIN. Thyroidectomy.
Staff—2. Dry clinic:
M. D. ALTSCHULE. Obstruction of the superior vena cava.
B. ALEXANDER. Blood bank.
MAX DAVIS and SAMUEL GILMAN. Venous pressure changes in lower extremities during and after abdominal surgery.
S. B. BEASER. Rare earth anticoagulants.
JACOB FINE. Thrombophlebitis and embolism, diagnostic and therapeutic considerations.
B. ALEXANDER. Polycythemia vera in peripheral vascular disease.
B. F. MASSELL and S. B. BEASER. Evaluation of therapy of peripheral vascular disease.
JACOB FINE. Adrenal cortical hormones in shock and hemorrhage.

Thursday

GENERAL SURGERY

Staff—9. Dry clinic:
S. S. HANFLIG. Use of traction in treatment of cervical arthritis.
M. H. ROGERS. Treatment of acute subdeltoid bursitis by needling, novocain and irrigation; mechanics of fracture of surgical neck of humerus, methods of reduction.
ARMIN KLEIN. Chemotherapy of acute sepsis of bones and joints.
DR. RHEINGOLD and W. S. ALTMAN. Delayed roentgenological evidence of fracture.
M. H. ROGERS. Intervertebral disc, orthopedic aspects.
W. JASON MIXTER. Intervertebral disc, neurological and surgical aspects.
DAVID AYMAN. Results of sympathectomy for hypertension.
Staff—10:30. Operative clinic:
R. H. SMITHWICK. Sympathectomy for hypertension.
W. JASON MIXTER. Removal of intervertebral disc.
M. H. ROGERS. Manipulation for chronic adhesive bursitis.
Staff—2. Dry clinic:
ALFRED HURWITZ. Sulfanilamide vs. zinc peroxide in the treatment of phagedenic ulcer.
LOUIS ZETZEL. The Miller-Abbott tube.
M. D. ALTSCHULE. Effect of abdominal surgery on respiratory dynamics.
H. L. BLUMGART. The surgical risk in cardiac patients.
JACOB FINE. Treatment of intestinal distention by sulfaguanidine.
ARNOLD STARR. Sulfaguanidine for the sterilization of isolated loops of colon.

GENITO-URINARY SURGERY

Staff—9. Dry clinic:
E. L. PRIEN. A new method for stone analysis.
D. B. STEARNS. Parathyroid disease and urinary lithiasis.
G. C. PRATHER. Roentgenology of the kidney at operation.

B. E. GREENBERG. Use of cholinergic and adrenergic medication for ureteral stone passage.
H. A. KONTOFF. Hospital statistics on urinary lithiasis.
J. H. LIPTON. Clearance of infection in stone cases after operation.
D. B. STEARNS. Diagnosis of calyceal calcifications.
H. A. KONTOFF. Renal tumor statistics of the hospital.
Demonstration: Surgical specimens of renal tumors with pyelographic and microscopic data.
E. G. CRABTREE—11. Operation: Excision of renal tumor.
Staff—2. Dry clinic:
M. L. BRODNY. Fractional pyelography.
J. H. Lipton. Sulfonamide drugs in surgical wounds and postoperative infections.
B. E. GREENBERG. Methylene blue treatment for tuberculosis of the bladder.
E. L. PRIEN. Renal injury from sulfathiazole and sulfapyridine, nature of the lesion.
D. B. STEARNS. Undescended testicle, age groups.
M. L. BRODNY. Urological study of enuresis cases.
DR. FISHMAN. Denervation of the kidney, end-results of 200 cases.
B. E. GREENBERG. Organization and function of a sterility clinic.
NATHAN CHASET. Hypertensive disease in urology.

Friday

GENERAL SURGERY

Staff—9. Dry clinic:
C. G. MIXTER. Results of surgery of colon neoplasms classified according to extent of lesion.
L. E. BARRON. Pitfalls in diagnosis of carcinoma of stomach, observations in 300 cases.
C. G. MIXTER. Results of surgery of gastric neoplasms classified according to extent of lesion.
I. T. NATHANSON. Surgical management of lymph nodes in cancer surgery.
K. PRESSER. Differential diagnosis of gastric ulcer by radiography.
JACOB FINE—10:30. Operation: Colon resection.
C. G. MIXTER—10:30. Operation: Gastric resection.
Staff—2. Dry clinic:
A. M. SELIGMAN. Vitamin K in treatment of hypoprothrombinemia in infants.
J. J. MICHAELS and MISS E. COHEN. Psychiatric considerations in surgical patients.
B. RISEMAN. The surgical treatment of angina pectoris.
S. A. ROBINS. Diagnosis of non-calcified dermoid cysts.
A. M. SELIGMAN. Carcinogenic agents.
H. L. CABITT. Surgical management of pulmonary tuberculosis.
AARON THURMAN. Thoracic esophageal diverticulum.

OTORHINOLARYNGOLOGY

Staff—9. Dry clinic:
SAMUEL CLINE. Tuberculous laryngitis.
OSCAR HIRSCH. Sphenoid approach through submucous septum.
A. J. GORNEY. Lempert's simple and radical mastoid operations.
S. W. GARFIN. Transseptal approach for dacryocystitis.
H. F. FRIEDMAN. Radiation for carcinoma of larynx by the Coutard method.
BENJAMIN RISEMAN. Cavernous sinus thrombosis.
LOUIS M. FREEDMAN. Coutard radiation therapy for carcinoma of larynx, end-results; Lempert technique for simple and radical mastoidectomy.
LOUIS M. FREEDMAN. Operation: Lempert for mastoiditis.

Daily—9 to 5

SCIENTIFIC EXHIBIT

JOSEPH GOODMAN. Pathogenic fungi in foot infections.
H. F. FRIEDMAN. Malignant disease before and after treatment by radiation.
ABRAHAM RUDY and S. R. MUELLNER. Neurogenic bladder in diabetes mellitus.
JULIUS LOMAN. Action of autonomic drugs on the gastro-intestinal and genito-urinary tracts.
S. A. ROBINS. Urethrography and cystography.
W. S. ALTMAN and A. L. HERMANSON. Cholangiography.
L. NATHAN and DR. THOMA. Cysts and tumors of mouth and jaw.
JULIUS LOMAN. Cerebral arteriography.

FAULKNER HOSPITAL

Wednesday

GENERAL SURGERY

E. L. YOUNG, A. R. KIMPTON, F. G. BALCH, H. K. SOWLES, R. F. SHELDON, E. E. O'NEIL, R. S. TITUS, and R. J. HEFFERNAN—8. Operative clinic.
S. C. WIGGIN—8. Anesthesia exhibits.
J. B. HAZARD—8. Pathological specimen, slides.
E. L. YOUNG, F. G. BALCH, DR. QUIMBY, A. R. KIMPTON, H. K. SOWLES, R. F. SHELDON, R. J. HEFFERNAN, R. S. TITUS, DR. STRAUSS, DR. MALONEY, and E. E. O'NEIL—2. Dry clinic.
HARVEY MORRISON—2. X-ray demonstrations.

Thursday

ORTHOPEDIC SURGERY

E. G. BRACKETT, H. C. MARBLE, G. M. MORRISON, J. D ADAMS, and OTTO J. HERMANN—8. Operative clinic.
HARVEY MORRISON—8. X-ray demonstrations.
E. G. BRACKETT, A. P. AITKEN, J. L. DOHERTY, H. C. MARBLE, OTTO J. HERMANN, HARVEY MORRISON, J. D. ADAMS, and H. L. JOHNSON—2. Dry clinic.
JOHN HOMANS, C. G. MIXTER, R. H. SMITHWICK, DR. WHITE, E. E. O'NEIL, H. C. MARBLE, and J. S. HODGSON—4. Symposium: Causalgia.

BEVERLY HOSPITAL

Thursday

GENERAL SURGERY

Staff.—9. Demonstration of newly constructed operating room with elimination of explosion and fire hazards.

FRACTURES AND OTHER TRAUMAS

PEER P. JOHNSON, JOHN D. ADAMS, and RICHARD E. ALT—9. Dry clinic. Discussion by CLAY RAY MURRAY, ROBERT H. KENNEDY, and FREDERIC W. BANCROFT

MALDEN HOSPITAL

Friday

GENERAL SURGERY

I. J. WALKER and staff—9. Operations: Gastro-intestinal.
I. J. WALKER and staff—2. Dry clinic.

OBSTETRICS AND GYNECOLOGY

NICHOLAS A. GALLAGHER—9. Operations: Gynecological.

MASSACHUSETTS MEMORIAL HOSPITALS

Monday

THORACIC SURGERY

J. W. STRIEDER—2. Symposium.

Tuesday

GENERAL SURGERY

HOWARD M. CLUTE and staff—8. Operative clinic.
FRANK E. BARTON—10. Symposium: Management of blood bank.
PHILLIPS L. BOYD—10. Dry clinic: Lymphogranuloma venereum with rectal involvement.
THOMAS J. ANGLEM—2. Symposium: Cancer of the breast.
FRANK E. BARTON—2. Transfusion service.

GENITO-URINARY SURGERY

SAMUEL N. VOSE and staff—9. Operative clinic.

OTORHINOLARYNGOLOGY

HAROLD L. BABCOCK and LEIGHTON F. JOHNSON—2. Operative and dry clinic.

Wednesday

GENERAL SURGERY

HOWARD M. CLUTE and staff—8. Operative clinic.
GEORGE LEVENE and EGON G. WISSING—9:30. Demonstration: X-ray examination of the rectum and sigmoid with special reference to the lateral view.
HOWARD M. CLUTE—10. Symposium: Stomach surgery.
FRANK E. BARTON—2. Transfusion service.

GENITO-URINARY SURGERY

SAMUEL N. VOSE—9. Symposium: Management of obstructing prostate.

THORACIC SURGERY

J. W. STRIEDER—2. Operative and dry clinic.

ORTHOPEDIC SURGERY

LOUIS G. HOWARD and staff—9. Operative and dry clinic.

OPHTHALMOLOGY

WILLIAM D. ROWLAND—9:30. Dry clinic.

OTORHINOLARYNGOLOGY

LEIGHTON F. JOHNSON—2. Dry clinic: Mediastinitis, 3 cases, 2 cures (with Howard M. Clute); endaural repair of postauricular fistula, 3 cases; osteomyelitis of frontal bone; Lempert's operation, endaural fenestration for otosclerosis.

Thursday

GENERAL SURGERY

HOWARD M. CLUTE and staff—8. Operative clinic.
MILO C. GREEN, CHESTER S. KEEFER, HOWARD M. CLUTE, HOLLIS L. ALBRIGHT, SAMUEL N. VOSE, and LEIGHTON F. JOHNSON—10. Use of sulfonamide group in surgery.
ARTHUR L. HANRAHAN—10. Operative and dry clinic: Treatment of varicose veins and ulcers.

OBSTETRICS AND GYNECOLOGY

C. WESLEY SEWALL and staff—8. Operative and dry clinic; ward walk.
C. WESLEY SEWALL and staff—2. Symposium: Obstetrical.
JOHN J. ELLIOTT. A ten-year study of bleeding in the third trimester of pregnancy.
OWEN C. MULLANEY. Prenatal and postnatal care.
JOHN C. V. FISHER. A ten-year survey of cesarean section.
MAX DAVIS. Physiology and clinical application of testosterone.
KENNETH W. SEWALL. A twenty-year survey of eclampsia.
HERMAN C. PETTERSON. Modern care of the newborn.

ORTHOPEDIC SURGERY

LOUIS G. HOWARD, ALBERT B. FERGUSON, and associates—9. Discussion of bone tumors.

OPHTHALMOLOGY

WILLIAM D. ROWLAND and RALPH H. HOPKINS—2. Operative clinic.

Friday

GENERAL SURGERY

HOWARD M. CLUTE and staff—9. Operative clinic.

GENITO-URINARY SURGERY

SAMUEL N. VOSE—9. Operative and dry clinic.

UNITED STATES MARINE HOSPITAL

Tuesday

GENERAL SURGERY

R. L. WAUGH and staff—8. Operative clinic: Hernioplasty, indirect, direct, and femoral; appendectomy; ligation of saphenous vein and hemorrhoidectomy.
R. L. WAUGH and staff—11. Dry clinic: Appendicitis, intestinal parasites, and terminal ileitis.

FRACTURES AND OTHER TRAUMAS

R. L. WAUGH and staff—8. Operative clinic: Internal derangement of knee-joint; bunion; closed treatment, double-pin method, fracture both bones of leg, open treatment; vitallium plate, both bones forearm.
R. L. WAUGH and staff—1. Dry clinic: Skeletal traction and countertraction methods applicable to ordinary extension splints in the treatment of fractures of lower extremity; vitallium in fractures, injuries of the wrist and rupture of biceps brachii.

Friday

GENERAL SURGERY

R. L. WAUGH and staff—9. Operative clinic: Hernioplasty, indirect, direct and femoral; appendectomy; ligation of saphenous vein and hemorrhoidectomy.
R. L. WAUGH and staff—11. Dry clinic: Appendicitis, intestinal parasites, and terminal ileitis.

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MASSACHUSETTS EYE AND EAR INFIRMARY

Monday

OPHTHALMOLOGY

F. H. VERHOEFF and WILLIAM P. BEETHAM—2:15. Dry clinic: Cataract surgery.

Tuesday

OPHTHALMOLOGY

PAUL A. CHANDLER, FRED S. THORNE, TRYGVE GUNDERSEN, and PAUL G. HAIRE—9. Operations.
PAUL A. CHANDLER—2:15. Glaucoma, indications for operation.
SAMUEL T. CLARKE—2:15. Goniotomy, medical treatment.

Wednesday

OPHTHALMOLOGY

WILLIAM P. BEETHAM, SAMUEL H. WILKINS, BRENDAN D. LEAHEY, and DAVID G. COGAN—9. Operations.
E. B. DUNPHY—2:15. Strabismus, orthoptic training.
VIRGIL G. CASTEN—2:15. Strabismus, operative treatment.

Thursday

OPHTHALMOLOGY

EDWIN B. GOODALL, RALPH H. RUGGLES, MERRILL J. KING, and HERMAN GROSSMAN—9. Operations.
MERRILL J. KING—2:15. Dry clinic: Retinal separation.
BRENDAN D. LEAHEY—2:15. Dry clinic: Keratoplasty.

Friday

OPHTHALMOLOGY

BENJAMIN SACHS and JOHN G. JENNINGS—9. Operations.
Staff—9. Demonstrations:
WILLIAM P. BEETHAM. Slit Lamp.
GARRETT L. SULLIVAN. Perimetry.
VIRGIL G. CASTEN. Neuro-ophthalmology.
SAMUEL T. CLARKE. Gonioscopy.
T. L. TERRY—2:15. Dry clinic and lantern demonstrations of pathological specimens.
V. H. KAZANJIAN—2:15. Ophthalmoplastic surgery.

Days to be Announced

OTORHINOLARYNGOLOGY

A. S. MACMILLAN. Interpretation of sinus and mastoid x-rays.
L. G. RICHARDS. Bronchoscopy problems.
C. T. PORTER. Orbital abscess, diagnosis and treatment.
L. A. SCHALL. Cancer of the nose and sinuses; laryngeal cancer.
G. B. FRED. Osteomyelitis of the frontal bone.
H. G. TOBEY. Allergy, otolaryngological considerations.
P. E. MELTZER and C. I. JOHNSON. The fenestration operation.
RUTH GUILDER. The deaf child.
V. H. KAZANJIAN. Rhinoplastic surgery.
PHILIP MYSEL. Labyrinthectomy, review of cases.
C. M. KOS. Meningitis, review of cases.

SCIENTIFIC EXHIBIT

T. L. TERRY. Pathological laboratory open for inspection.
DAVID G. COGAN. Howe laboratory and library open for inspection.

CHILDREN'S HOSPITAL

Tuesday

GENERAL SURGERY

W. E. LADD and associates—10:30. Dry clinic: Surgical diseases of the gastro-intestinal tract in childhood. Atresia, stenosis, and malrotation; pyloric stenosis; intussusception; appendicitis, followed by questions and discussion.

GENITO-URINARY SURGERY

W. E. LADD and associates—9. Dry clinic: Surgical diseases of the genito-urinary tract in infancy and childhood. Embryoma, malformations, exstrophy and epispadias, followed by questions and discussion.

ORTHOPEDIC SURGERY

F. R. OBER and associates—9. Operations.

Wednesday

GENERAL SURGERY

W. E. LADD and associates—9. Operations.

ORTHOPEDIC SURGERY

F. R. OBER and associates—9. Dry clinic:
W. A. ELLISTON—9. Study in bone growth and resorption of the epiphyseal plate.
L. M. MCDERMOTT—9:30. Equalization of leg length; leg lengthening.
P. W. HUGENBERGER—10. Tuberculosis of bone.
A. H. BREWSTER—10:30. Arthrodesis of the foot in spastic paralysis.
Staff—11. Symposium on infantile paralysis, operative treatment.

Thursday

GENERAL SURGERY

W. E. LADD and associates—9. Dry clinic: Plastic surgery in childhood. Harelip and cleft palate; burns, early and late treatment; hands, syndactylism and polydactylism; plastic for malformation about anus, followed by questions and discussion.

THORACIC SURGERY

W. E. LADD and associates—10:30. Dry clinic: Chest, chronic suppuration; heart, patent ductus arteriosus, with questions and discussion.

NEUROSURGERY

W. E. LADD and associates—10:30. Dry clinic.

ORTHOPEDIC SURGERY

F. R. OBER and associates—9. Operations.

Friday

GENERAL SURGERY

W. E. LADD and associates—9. Operations.

ORTHOPEDIC SURGERY

F. R. OBER and associates—9. Dry clinic:
M. G. KATZEFF—9. Early treatment of club-feet.
R. H. MORRIS—9:30. Treatment of the difficult club-feet.
F. R. OBER—9:50. Treatment of congenital elevation of the scapula.
DR. GREEN—10:20. Osteochondritis dissecans.

M. G. KARP—10:45. Fractures about the elbow in childhood.
Staff—11:15. Congenital malformations.

Daily—2 to 5

SCIENTIFIC EXHIBIT

Exhibit of pathological specimens, x-rays, photographs, and charts from the surgical, orthopedic and neurosurgical services.

NEW ENGLAND MEDICAL CENTER

JOSEPH H. PRATT DIAGNOSTIC HOSPITAL

Monday

GENERAL SURGERY

Staff—2. Dry clinic:
JOSEPH H. PRATT. Surgical problem in pancreatic disease.
WILLIAM DAMESHEK. Indications for splenectomy, case reports.
JOHN D. ADAMS. Orthopedic subject, to be announced.
WALTER E. GARREY. Peritoneoscopy.

Tuesday

GENERAL SURGERY

Staff—2. Dry clinic:
C. H. LAWRENCE. Masculinizing tumors.
R. H. BETTS. Subject to be announced.
WILLIAM M. SHEDDEN. Subject to be announced.
EDWARD T. WHITNEY. Subject to be announced.

Wednesday

GENERAL SURGERY

Staff—2. Dry clinic:
RICHARD H. OVERHOLT. Operability of primary carcinoma of the lung.
L. E. PHANEUF. Subject to be announced.
S. J. THANNHAUSER. Liver function tests as an aid to gall-bladder surgery.
H. E. MACMAHON. Subject to be announced.

BOSTON FLOATING HOSPITAL

Thursday

GENERAL SURGERY

RICHARD WAGNER and W. S. LEVENSON—2. Endocrinology and surgery.
DR. MCDONALD and R. G. FREEMAN—2. Appraisal of the host, nutrition, personality.
DR. MCDONALD, W. S. LEVENSON, DR. WERTHESSEN, and H. E. MACMAHON—2. Adrenal dysfunction.

GENITO-URINARY SURGERY

H. A. CHAMBERLIN—2. Genito-urinary surgery in children.

THORACIC SURGERY

RICHARD H. OVERHOLT, R. H. BETTS, and DR. WELLER—2. Tidal drainage; lung abscess.

OTORHINOLARYNGOLOGY

W. A. MACCOLL—2. Tonsils and adenoids, indications for removal.

BOSTON DISPENSARY—PRATT CLINIC

Days to be Announced

OTORHINOLARYNGOLOGY

GEORGE KELEMEN. Pathogenesis of traumatic cholesteatome, lantern slides; surgery of the tonsil after middle life; pathways of infection in the ear, lantern slides.
PHILIP E. MELTZER. Surgical anatomy of the temporal bone.

UNITED STATES NAVAL HOSPITAL

Tuesday

GENERAL SURGERY

J. J. A. MCMULLIN and staff—9. Operations.
JAMES J. REGAN—9. Demonstrations of technique used in flight physical examinations, with discussion of United States Naval requirements.

OTORHINOLARYNGOLOGY

CHARLES H. ALLMAN—9. Dry clinic: Bronchoscopy for bronchiectasis; pulmonary abscess and postoperative atelectasis; synopsis of case histories and accomplishments.

Wednesday

GENERAL SURGERY

LAWRENCE J. MCCARTHY and staff—9. Operations.
THOMAS H. PETERSON—9. Shoulder injuries; discussion of case histories; x-ray findings.
WALTER E. GARREY—9. Dry clinic: Circulatory diseases of the extremities; case histories.

Thursday

GENERAL SURGERY

WALTER E. GARREY and staff—9. Operations.
LAWRENCE J. MCCARTHY and WALTER E. GARREY—9. Gastro-intestinal clinic: Partial gastrectomy for pyloric obstruction with a synopsis of case histories.

GENITO-URINARY SURGERY

E. ROSS MINTZ—9. Dry clinic: Presentation of urological cases with histories and x-ray findings.

Friday

GENERAL SURGERY

THOMAS H. PETERSON—9. Operations.

OBSTETRICS AND GYNECOLOGY

JOSEPH B. DOYLE—10. Colored moving pictures of spinal anesthesia in obstetrics; discussion of case histories.

COLLIS P. HUNTINGTON MEMORIAL HOSPITAL

Monday

GENERAL SURGERY

Staff—2:15. Dry clinic.
JOSEPH C. AUB. Recent advances in our knowledge of bone diseases.
CHANNING C. SIMMONS. Malignant tumors of bone.

RICHARD DRESSER. Radiographic demonstration of bone tumors and certain rare forms of skeletal disease.
CHARLES E. DUNLAP. Carcinogenic agents.
CLIFFORD C. FRANSEEN. Industrial cancer.

Thursday

GENERAL SURGERY

Staff—2.15. Dry clinic:
GRANTLEY W. TAYLOR. Choice of treatment in cancer of the oral cavity.
DAVID WEISBERGER. Changes in the oral mucous membrane due to vitamin deficiency.
SHIELDS WARREN. Treatment of leukemia by radio-active substances.
IRA T. NATHANSON. Relation of the hormones to malignant diseases.

PONDVILLE HOSPITAL

Wednesday

GENERAL SURGERY

E. M. DALAND and associates—9. Operative and dry clinics.
SHIELDS WARREN and associates—9. Demonstration: Pathological.
CHARLES DUMAS and associates—9. Exhibit: Bone tumors.

OBSTETRICS AND GYNECOLOGY

JOE V. MEIGS and associates—9. Operative and dry clinic: Gynecological cancer.

GENITO-URINARY SURGERY

ROGER C. GRAVES—9. Operative and dry clinic: Urological cancer.

SALEM HOSPITAL

Tuesday

GENERAL SURGERY

W. G. PHIPPEN, DONALD A. NICKERSON, and S. A. WILSON—10. Dry clinic: Uses and abuses of laboratory and roentgenological procedures in abdominal surgery.
E. L. PEIRSON—11. Prostatic surgery with some newer methods of diagnostic approach.

Friday

GENERAL SURGERY

Staff—10. Clinical pathological conference.

EVANGELINE BOOTH MATERNITY HOSPITAL

Days to be Announced

OBSTETRICS AND GYNECOLOGY

A. K. PAINE, W. J. MCDONALD, H. S. FINKEL, M. G. BERLIN, J. E. HOPKINS, D. C. GOLDFARB, A. A. LEVI, L. ALBERT, S. ELLIS, J. TARTAKOFF, and S. SIDELL. Operative and dry clinics.

Hospital Library
JUN 3 1941
Medical Library

SURGERY Gynecology and Obstetrics

With International Abstract of Surgery

VOLUME 72 June, 1941 NUMBER 6

The Newer Concepts of Meat in Nutrition

Meat
and the Anemias

THE discovery of the etiologic vector in pernicious anemia has brought liver into prominence as the best source of the antianemic factor, and kidney has been revealed as almost equally potent.

Muscle meat contains the extrinsic factor of Castle[1] which, on combination with the intrinsic factor found in the normal stomach, forms the antianemic principle.

Liver and kidney are the prime sources of this principle and are exceedingly rich in iron. Muscle meats too contain much of this element, in equally available form, as demonstrated by the dipyridyl method.[2] Meat is also an excellent source of copper, essential for iron utilization. Hence the inclusion of adequate quantities of meat (particularly visceral meats) in the diet is important as well in the prevention as in the active treatment of the hypochromic anemias.

As pointed out by Hawley and Maurer-Mast,[3] the dietary in both primary and secondary anemia should perform a multiple function. It should contribute the antianemic principle and available iron, and in addition the proteins, vitamins and other minerals needed for good nutrition. Meat cannot satisfactorily be omitted from the dietaries in these disorders.

1. Castle, W. B., and Locke, E. A.: Observations of the Etiologic Relationship of Achylia Gastrica to Pernicious Anemia, J. Clin. Invest. *6*:2, 1928.
2. Sherman, W. C.; Elvehjem, C. A., and Hart, E. B.: Further Studies on Availability of Iron in Biological Materials, J. Biol. Chem. *107*:383 (Nov.) 1934.
3. Hawley, E. E., and Maurer-Mast, E. E.: The Fundamentals of Nutrition, Springfield, Charles C. Thomas, 1940.

ACCEPTED AMERICAN MEDICAL ASSN Council on Foods

The Seal of Acceptance denotes that the statements made in this advertisement are acceptable to the Council on Foods and Nutrition of the American Medical Association.

American Meat Institute
CHICAGO

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THE HELPING HAND

THE POSTOPERATIVE ROAD to recovery is frequently an uphill grade, beset with the pitfalls of gas pains, distention, ileus, and urinary retention. More and more surgeons are finding in Prostigmin the helping hand that aids the patient through a smoother convalescence. Routine use of Prostigmin Methylsulfate 1:4000 prevents postoperative distention and urinary retention by maintaining the tone of intestinal and bladder musculature. The recommended dosage schedule consists of an intramuscular injection of 1 cc (1 ampul) of the 1:4000 solution immediately after operation, followed by 5 similar 1-cc injections at 2-hour intervals. Additional injections may be given if necessary; by effects from the use of Prostigmin in therapeutic doses are conspicuously absent.

*PROSTIGMIN METHYLSULFATE 1:4000, 1 cc, boxes of 12 and 100 ampuls, blue label. For the prevention of postoperative distention.

PROSTIGMIN METHYLSULFATE 1:2000, 1 cc, boxes of 12 and 50 ampuls, buff label. For the treatment of postoperative distention and of myasthenia gravis.

†PROSTIGMIN BROMIDE Tablets, 15 mg., vials of 20. For the oral treatment of myasthenia gravis.

**Dimethylcarbamic ester of 3-hydroxyphenyl-trimethylammonium methylsulfate.*

†*Dimethylcarbamic ester of 3-hydroxyphenyl-trimethylammonium bromide.*

HOFFMANN-LA ROCHE, INC.
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PROSTIGMIN METHYLSULFATE 1:4000

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